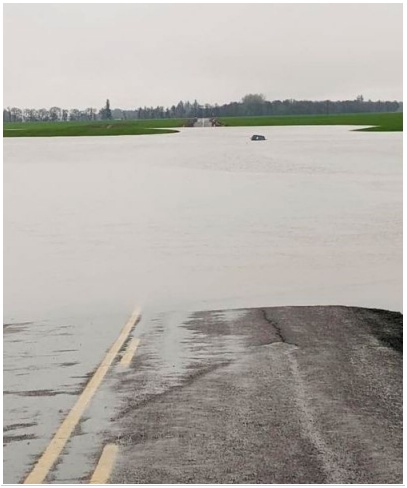
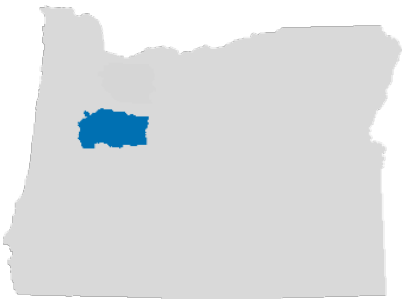


Linn County

MULTI-JURISDICTIONAL NATURAL HAZARDS MITIGATION PLAN

VOLUME I: BASIC PLAN

- Linn County
- City of Gates
- City of Halsey
- City of Harrisburg
- City of Lebanon
- City of Lyons



- City of Millersburg
- City of Scio
- City of Sodaville
- City of Sweet Home
- City of Tangent
- Lyons Rural Fire District

FEMA

Effective Month X, 2025 through Month X, 2030

The *2025 Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan* is a living document that will be reviewed and updated periodically. It will be integrated with existing plans, policies, and programs. The Disaster Mitigation Act of 2000 (DMA2K) and the regulations contained in 44 CFR 201 require that jurisdictions maintain an approved Natural Hazards Mitigation Plan to receive federal funds for pre- and post-disaster mitigation grants.

Comments, suggestions, corrections, and additions are encouraged to be submitted by all interested parties. For further information and to provide comments, contact:

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Linn County developed this Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP) in collaboration with the Cities of Gates, Halsey, Harrisburg, Lebanon, Lyons, Millersburg, Scio, Sodaville, Sweet Home, and Tangent, and the Lyons Rural Fire District. Special thanks to Linn County Planning and Emergency Management staff for their leadership and logistical resources and skills in convening the participating jurisdictions.

The MJ-NHMP was funded in part through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance Grant Program (HMGP). The Oregon Department of Land Conservation and Development (DLCD) received a FEMA HMGP-Post Fire grant for FM-5327-OR through the Oregon Department of Emergency Management to assist Linn County and participating jurisdictions with the update.

Cover photos credits: Upper left: Poor air quality due to smoke in Albany, City of Albany staff; Upper right: Riverfront Park in Harrisburg, 2015 Willamette River flood, provided by Michele Eldridge; Lower left: "Linn County Road Department employees use a D6 Cat to clear a residential driveway access on Brock Drive near Scio," Linn County Reporter February 2024; Center: Aftermath of Beachie Creek fire in Gates, provided by Traci Archer; Lower right: Submerged vehicle on Abraham Drive near Peoria. Flooding was caused by ice melt, which had the Road Department close several roads due to high water for a day or two, Linn County Reporter February 2024.

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TABLE OF VOLUMES

VOLUME 1: BASIC PLAN

Executive Summary xi
Section 1: Introduction 1-1
Section 2: Risk Assessment 2-1
Section 3: Mitigation Strategy 3-1
Section 4: Plan Implementation and Maintenance 4-1

VOLUME II: CITY AND DISTRICT ADDENDA

Gates GA-1
Halsey HL-1
Harrisburg HB-1
Lebanon LB-1
Lyons LY-1
Lyons Rural Fire District LFD-1
Millersburg ML-1
Scio SC-1
Sodaville SV-1
Sweet Home... ..... SH-1
Tangent TG-1

VOLUME III: APPENDICES

Appendix A: Planning and Public Process A-1
Appendix B: Community Profile B-1
Appendix C: Economic Analysis of Natural Hazard Mitigation Projects C-1
Appendix D: Grant Programs and Resources D-1
Appendix E: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon E-1
Appendix F: OCCRI Future Climate Projections, Linn County, Oregon F-1
Appendix G: Resolutions, FEMA Plan Review Tool G-1

VOLUME I:
BASIC PLAN

TABLE OF CONTENTS

Executive Summary xi
Section 1: Introduction 1-1
What is Natural Hazard Mitigation? 1-1
Why Develop this Mitigation Plan? 1-2
What Federal Requirements Does This Plan Address? 1-2
What is the Policy Framework for Natural Hazards Planning in Oregon? 1-2
Who Participated in Developing the Plan? 1-3
How is the Plan Organized? 1-3
Volume I: Basic Plan 1-4
Volume II: Jurisdictional Addenda 1-6
Volume III: Appendices 1-6
Section 2: Risk Assessment 2-1
What is a Risk Assessment? 2-2
Hazard Identification 2-2
Dam Failure 2-3
Drought 2-7
Earthquake 2-14
Flood 2-23
Landslide 2-35
Smoke and Poor Air Quality 2-44
Volcano 2-52
Wildfire 2-56
Severe Weather: Extreme Heat, Windstorm/Tornado, and Winter Storm/Ice Storm 2-67
Federal Disaster and Emergency Declarations 2-83
Vulnerability Summary 2-85
Population 2-85
Economy 2-86
Environment 2-87
Built Environment, Critical Facilities, and Infrastructure 2-88
Historic and Cultural Resources 2-88
National Flood Insurance Program and Floodplain Ordinance Requirements 2-89
Risk Assessment 2-91
Loss Estimation and Exposure Assessment 2-92
Local Risk Assessment 2-92
NHMP Community Survey 2-99
Section 3: Mitigation Strategy 3-1

Mitigation Plan Mission 3-1
Mitigation Plan Goals 3-1
Action Item Development Process 3-2
Mitigation Strategy Actions 3-2
Section 4: Plan Implementation and Maintenance 4-1
Implementing the Plan 4-1
Plan Adoption and Approval 4-1
Convener 4-1
Coordinating Body 4-2
Implementation through Existing Programs 4-3
Plan Maintenance 4-5
Maintenance Process 4-5
Project Prioritization Process 4-5
Continued Public Involvement and Participation 4-8
Five-Year Review of Plan 4-8

LIST OF FIGURES

Figure 2-1. Understanding Risk 2-1
Figure 2-2. Three Phases of Risk Assessment 2-2
Figure 2-3. National Inventory of Dams, Locations in Linn County, Oregon 2-5
Figure 2-4. NID Structure Details for Foster Log Pond Dam 2-5
Figure 2-5. SPEI 24 for Linn County, 12-months Ending in September (1895-2024) 2-9
Figure 2-6. SWSI Values for the Willamette Basin (1982-2016) 2-10
Figure 2-7. U.S. Drought Monitor Percent Area of Linn County 2000-2024 (February) 2-11
Figure 2-8. Projected Future Drought in Linn County 2-13
Figure 2-9. Earthquake Epicenters (1841-2022), Active Faults and Liquefaction Susceptibility 2-17
Figure 2-10. Cascadia Subduction Zone Damage Potential 2-20
Figure 2-11. CSZ Mw 9.0 Earthquake Loss Ratio by Linn County Community 2-21
Figure 2-12. Earthquake Loss Ratio from Turner Mill Creek Fault Mw 6.6 2-22
Figure 2-13. Location and Extent of Flood Hazard in Linn County 2-25
Figure 2-14. Flood Depth Grid Example in Rural Linn County, Oregon 2-26
Figure 2-15. Hydrograph of Santiam River at Detroit Dam 2-29
Figure 2-16. Ratio of Flood Loss Estimates by Linn County Community 2-31
Figure 2-17. 100-year Flood Zone and Building Loss Estimates Example in Rural Linn County 2-32
Figure 2-18. Common Types of Landslides in Oregon 2-37
Figure 2-19. Historic Landslide Inventory and Landslide Susceptibility Rating 2-38
Figure 2-20. Landslide Susceptibility Exposure by Linn County Community 2-41
Figure 2-21. Ambient Air Monitoring in Oregon in 2022 2-46
Figure 2-22. PM2.5 Daily AQI Values, 2005 to 2024, Linn County, Oregon 2-48
Figure 2-23. City of Albany Poor Air Quality, September 9, 2020 2-49
Figure 2-24. Fire and Smoke Map July 19, 2024, for the Linn County area 2-50
Figure 2-25. Volcano Hazard Area 2-53
Figure 2-26. Regional Tephra-fall Maps 2-54
Figure 2-27. Example of an Interface Community 2-58
Figure 2-28. Example of an Intermix Community 2-58

Figure 2-29. Linn County Wildland Urban Interface Map 2-60
Figure 2-30. Change in Number of Days with Extreme Vapor Pressure Deficit in Linn County 2-62
Figure 2-31. Wildfire Risk Exposure by Linn County Community 2-64
Figure 2-32. Distribution of Social Vulnerability Index for Linn County Communities 2-66
Figure 2-33. Linn County Overall Social Vulnerability Map 2-66
Figure 2-34. Metrics and Definitions of Heat Extremes 2-68
Figure 2-35. Oregon Climate Divisions 2-78
Figure 2-36. Ice Storm Risk for Linn County 2-82
Figure 2-37. Ranking Historic Frequency 2-95
Figure 2-38. Ranking Probability 2-96
Figure 2-39. Ranking Vulnerability 2-97
Figure 2-40. Ranking Maximum Threat 2-98
Figure 4-1. Action Item and Project Review Process 4-6
Figure 4-2. Benefit Cost Decision Criteria 4-7

LIST OF TABLES

Table 1-1. Linn County Hazard Identification with Changes 1-4
Table 2-1. Linn County Hazard Identification 2-3
Table 2-2. Flood Exposure 2-34
Table 2-3. Landslide Susceptibility Exposure 2-39
Table 2-4. Air Quality Index Health Category Descriptions 2-47
Table 2-5. Air Quality Index Ranges and Episode Stages for PM2.5 and Ozone 2-48
Table 2-6. Distribution of WUI Area by Fire Protection District 2-59
Table 2-7. Projected Future Changes in Extreme Heat Metrics in Linn County 2-70
Table 2-8. Probability of Severe Wind Events (Region 3) 2-76
Table 2-9. Winter Storm Severity Index 2-79
Table 2-10. FEMA Major Disaster, Emergency, and Fire Management Assistance Declarations 2-84
Table 2-11. NFIP Flood Insurance Details 2-90
Table 2-12. Linn County Local Risk Assessment 2-99
Table 3-1. Completed Mitigation Strategy Actions – Linn County 3-4
Table 3-2. Mitigation Actions Removed from Linn County Mitigation Strategy 3-5
Table 3-3. Ongoing Mitigation Strategies – Linn County 3-7
Table 3-4. Short-term, Medium-term, and Long-term Mitigation Actions for Linn County 3-11
Table 4-1. Natural Hazards Mitigation Plan Update Toolkit 4-9

EXECUTIVE SUMMARY

Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (NHMP)

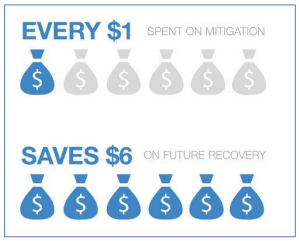
2025 Update

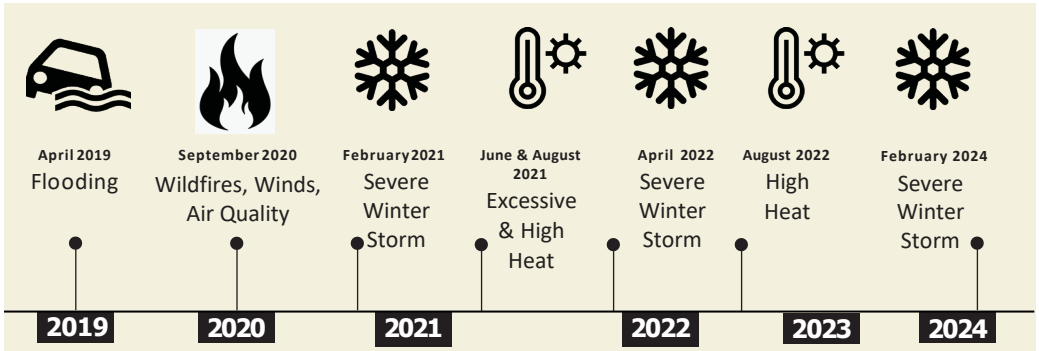
The Linn County NHMP focuses on natural hazards that historically impacted Linn County and the cities within and that could affect communities in the future. It is intended to assist jurisdictions reduce the risk from natural hazards by identifying resources, information, and strategies. It is also intended to guide and coordinate mitigation activities throughout the county.

What natural hazards affect Linn County?

Natural hazards pose a threat to the county's economy, people's health and property, infrastructure, and natural resources and ecosystems. Planning for natural hazards is vital due to potentially devastating effects.

Excessive heat, flooding, wildfires, windstorms, and winter storms have posed threats the last several years. These and other natural hazards could greatly affect the county in the future. Flooding is a primary concern in western parts of the county. Wildfires and landslide are concerns in steep and forested eastern areas of the county. Extreme heat and winter storms impact the entire county. The Cascadia Subduction Zone off the coast of Oregon and crustal faults within the county place it in danger of significant earthquake damage.





Recent Natural Hazard Events

Earthquake: Minor earthquakes historically occurred in the Cascade foothills. Since 2019, a cluster of small earthquakes have happened near Lacomb, with the largest on October 7, 2022, with a 4.4 magnitude on the Richter scale. The 1993 Scotts Mills earthquake in Marion County was magnitude 5.7.

Excessive Heat: A high-pressure dome over the Pacific Northwest led to a stretch of extreme heat, shattering records from June 26-29, 2021. All time maximum temperatures were broken by 8 to 10 degrees. There were 123 fatalities across Oregon as well as widespread business closures and postponements of events.

Flood: During April 6-21, 2019, a strong atmospheric river produced up to 5 inches of rain in a 48-hour period. This heavy rain combined with snow melt caused flooding along many rivers in Western Oregon. The Willamette River near Harrisburg crested at 15.3 feet on April 9, 1.3 feet above flood stage, and on April 11 crested near Albany at 27.3 feet, 2.3 feet above flood stage. The county received assistance as a part of a Presidential Declaration (DR-4452).

Tornado: A tornado touched down near Harrisburg on June 18, 2023. Six other funnel cloud sitings occurred in the county since 2019.

Wildfire: The 2020 Labor Day wildfires grew explosively due to strong winds combined with extremely low relative humidity and exceptionally dry fuel conditions. Loss of life, homes, and businesses occurred in the Santiam Canyon and smoke and extremely poor air quality impacted the entire county. The wildfires and straight-line winds event was a Presidentially Declared Disaster (DR-4562).

Windstorm: Ten episodes with winds of magnitude 35-62 miles per hour occurred in Linn County between 2019 and 2023, including the 2020 straight-line winds event (DR-4562).

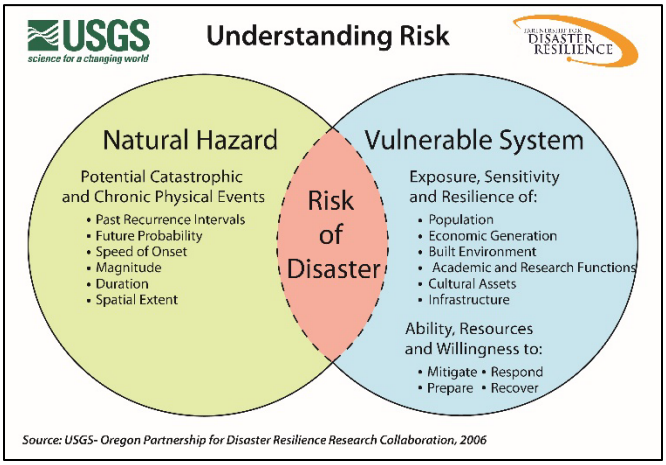
Winter Storm: Winter storm events included an ice storm in February 2021 and a late spring winter storm in April 2022. February 2024 brought an ice storm that impacted many residents. The 2021 and 2024 events were Presidentially Declared Disasters, DR-4599 and DR-4768, respectively.

Which hazards are of most concern in Linn County?

Risk assessment is a process of collecting information and assigning values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making. In other words, which natural hazards should be focused on when developing a course of action?

Conducting a risk assessment can provide information on the location of hazards, the value of land and property in hazard locations, and an analysis of risk to life, property, and the environment that may result from natural hazard events.

A risk assessment consists of three phases: hazard identification, vulnerability assessment, and risk analysis, as illustrated in the graphic to the right.



To inform the risk assessment, the Department of Geology and Mineral Industries analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, and exposure to landslide, channel migration, wildfire, and volcanic lahar.

Steering Committee Vulnerability Assessment

One element of assessing risk included the NHMP Steering Committee's vulnerability assessment. The assessment is based on the Oregon Department of Emergency Management (OEM) Hazard Analysis Methodology which combines factors of History, Probability, Vulnerability, and Maximum Threat to assess risk. The total score provides a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

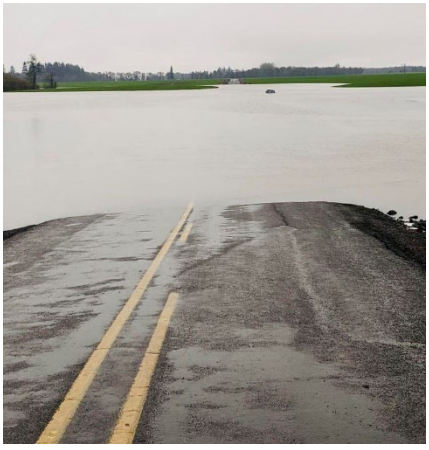
Summary of OEM Hazard Analysis Methodology County Level Risk Scores

HAZARD	Total Score
Winter Storm/Ice Storm	201.2
Extreme Heat	187.3
Smoke/Poor Air Quality	183.5
Flood	171.3
Drought	169.0
Earthquake (Cascadia)	160.7
Wildfire	158.9
Earthquake (Crustal)	155.7
Dam Failure	133.8
Windstorm/Tornado	116.5
Volcano	109.0
Landslide and Avalanche	106.4

The table to the left shows each hazard's potential impact on the county. City and district representatives then worked with the Department of Land Conservation and Development to refine the ranking of each hazard to focus on the probability and vulnerability for their jurisdiction.

During the NHMP update process, the Steering Committee identified two additional natural hazards, Extreme Heat and Dam Failure, to be addressed, with Smoke/Poor Air Quality identified as a hazard to be addressed separately from Wildfire.

Based on research by the Oregon Climate Change Research Institute, the Steering Committee considered how climate change impacts natural hazards affecting Linn County. These impacts are addressed throughout the NHMP and integrated into the consideration of probability.

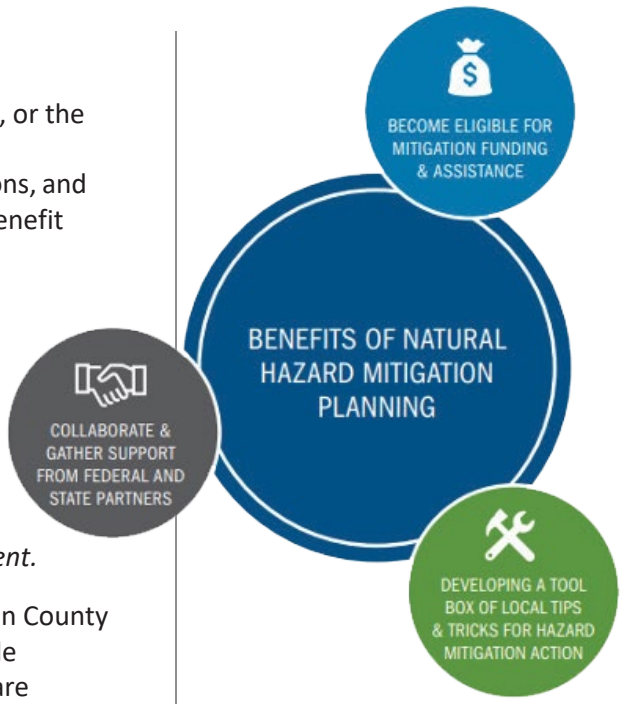


Understanding the risk of and vulnerabilities to natural hazards helped to inform the development of the NHMP's mitigation strategy.

How does this NHMP help reduce risk?

While it is impossible to predict exactly when natural hazards will occur, or the extent to which they will affect communities, with careful planning and collaboration among public agencies, private and non-profit organizations, and residents, it is possible to create a more resilient community that will benefit from long-term mitigation planning efforts.

The NHMP outlines Linn County's strategy to reduce or avoid long-term vulnerabilities to identified natural hazards. This **mitigation strategy** includes a mission, goals, and actions which the NHMP Steering Committee reviewed and updated during the Plan update process.



The **mission** of the Linn County NHMP is:

> *To reduce the impact of natural hazards on the community through planning, communication, coordination, and partnership development.*

Mitigation plan goals are more specific statements of direction that Linn County residents, businesses, and public and private partners can consider while working to reduce the county's risk from natural hazards. All the goals are important and are listed below in no particular order of priority:

> ***Goal 1:*** *Enhance coordination and communication among Linn County stakeholders to implement the Plan.*
>
> ***Goal 2:*** *Protect life, the built environment, and natural systems through County policies, procedures, and services.*
>
> ***Goal 3:*** *Protect life, the built environment, the economy, and natural resources through community-wide partnerships.*

Mitigation action items identified through the planning process are an important part of the mitigation strategy. Action items describe activities or projects that local jurisdictions can implement to reduce risk. Developing these actions was a multi-step, iterative process that involved brainstorming, discussion, review, and revisions by the NHMP Steering Committee.

Some of the actions are ongoing and conducted as a part of existing staff duties typically funded through existing budgets. Other actions are initiated and completed as discrete projects or activities that require grant or loan funding. The NHMP includes tables that organize the action items by completed, removed, and ongoing. Action items include information from each jurisdiction about the status, priority level, coordinating organization or department, an estimated timeline, potential funding sources, and other details.

Plan approval and implementation

In early 2025, the draft NHMP was reviewed by OEM and then reviewed and pre-approved by the Federal Emergency Management Agency (FEMA) pending adoption by each local jurisdiction included in the Plan. Once adopted locally, FEMA issued a final approval. The final FEMA-approved NHMP re-establishes eligibility for FEMA Hazard Mitigation Assistance funding, which includes three main programs: the Building Resilient Infrastructure and Communities program, the Hazard Mitigation Grant Program, and the Flood Mitigation Assistance program.

Accomplishing NHMP mitigation goals and actions depends upon regular Steering Committee participation and support from county, city, and district leadership. Thorough familiarity with the Linn County NHMP will result in the efficient and effective implementation of appropriate mitigation activities and a reduction in the risk and the potential for loss from future natural hazard events.

Who was involved in developing this NHMP?

The Linn County NHMP is the result of a collaborative effort between the county, cities, special districts, residents, public agencies, non-profit organizations, the private sector, and regional organizations. County, city, and district advisory groups guided the development process.

To get community input during the Plan update process, the NHMP Steering Committee conducted outreach, including a survey to collect feedback and risk assessment information, and a public review period of the draft mitigation strategy. Feedback received was considered by the Steering Committee to inform the Plan update.

SECTION 1: INTRODUCTION

Section 1 provides a general introduction to natural hazard mitigation planning in Linn County. In addition, it addresses the planning process requirements contained in 44 CFR 201.6(b) thereby meeting the planning process documentation requirement contained in 44 CFR 201.6(c)(1). The section concludes with a general description of how the plan is organized.

What is Natural Hazard Mitigation?

> *44 CFR 201.6 – The local mitigation plan is the representation of the jurisdiction's commitment to reduce risks from natural hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards. …*

The Federal Emergency Management Agency (FEMA) defines mitigation as "…the effort to reduce loss of life and property by lessening the impact of disasters… through risk analysis, which results in information that provides a foundation for mitigation activities that reduce risk." Said another way, natural hazard mitigation is a method of permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through long- and short-term strategies. Example strategies include policy changes, such as updated ordinances; projects, such as seismic retrofits to critical facilities; and education and outreach to targeted audiences, such as Spanish speaking residents or the elderly. Natural hazard mitigation is the responsibility of the "Whole Community" - individuals, private businesses and industries, community-based organizations, state and local governments, and the federal government.

What is Mitigation?

"Any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event."

- U.S. Federal Emergency Management Agency

Engaging in mitigation activities provides jurisdictions with a number of benefits, including increasing community resilience and capacity. Natural hazard mitigation can result in reduced loss of life, property, essential services, critical facilities, and economic hardship, as well as reduced short-term and long-term recovery and reconstruction costs. It also can result in increased cooperation and communication within a community through the planning process and increased potential for state and federal funding for coordinated recovery and reconstruction projects.

Why Develop this Mitigation Plan?

Linn County updated this Multi-Jurisdictional Natural Hazards Mitigation Plan (NHMP, MJ-NHMP, or Plan) in an effort to prepare for the long-term effects resulting from natural hazards. The plan update process was a collaboration between Linn County and the Cities of Gates, Halsey, Harrisburg, Lebanon, Lyons, Millersburg, Scio, Sodaville, Sweet Home, and Tangent, and the Lyons Rural Fire District. It is impossible to predict exactly when natural hazards will occur, or the extent to which they will affect the community. However, with careful planning and collaboration among public agencies, private sector organizations, community-based organizations, and residents, it is possible to create a resilient community that will benefit from long-term mitigation planning efforts.

What Federal Requirements Does This Plan Address?

> *44 CFR 201.6(a)(1) – A local government must have a mitigation plan approved pursuant to this section in order to receive HMGP project grants…*

In addition to establishing a comprehensive community-level mitigation strategy, the Federal Disaster Mitigation Act of 2000 (DMA2K) and the regulations contained in 44 CFR 201 require that jurisdictions maintain an approved NHMP in order to receive federal funds for mitigation projects. Local and federal approval of this Plan ensures that the county and listed jurisdictions will remain eligible for FEMA pre- and post-disaster Hazard Mitigation Assistance project funding which includes three programs: the Building Resilient Infrastructure and Communities (BRIC) program, the Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. Additionally, a FEMA-approved NHMP is required by Oregon Department of Emergency Management (OEM) to retain eligibility for the Emergency Management Performance Grant, which helps fund local emergency management programs.

Throughout the remainder of this section, relevant regulations from 44 CFR 201 are highlighted in call out boxes.

What is the Policy Framework for Natural Hazards Planning in Oregon?

Planning for natural hazards is an integral element of Oregon's Statewide Land Use Planning program, which began in 1973. All Oregon cities and counties have comprehensive plans and implementing ordinances that are required to comply with the Statewide Land Use Planning Goals. A challenge faced by state and local governments is to keep this network of local plans coordinated in response to the changing conditions and needs of Oregon communities.

Statewide Land Use Planning Goal 7: Areas Subject to Natural Hazards[1] calls for local plans to include inventories, policies, and ordinances to guide development so impacts to people and property from natural hazards are avoided or mitigated. Goal 7, along with other land use planning goals, has helped to reduce losses from natural hazards. Through risk identification and

[1] Statewide Land Use Planning Goal 7: https://www.oregon.gov/lcd/OP/Documents/goal7.pdf

the recommendation of risk-reduction actions, this NHMP aligns with the goals of each jurisdiction's Comprehensive Plan, helping to meet the requirements of Statewide Land Use Planning Goal 7.

The primary responsibility for the development and implementation of risk reduction strategies and policies lies with local jurisdictions. However, additional resources exist at the state and federal levels. Some of the key agencies in this area include OEM, Oregon Building Codes Division (BCD), Oregon Department of Forestry (ODF), Oregon Department of Geology and Mineral Industries (DOGAMI), and the Department of Land Conservation and Development (DLCD).

Who Participated in Developing the Plan?

The Linn County NHMP is the result of a collaborative effort between the county, cities, special districts, residents, public agencies, non-profit organizations, the private sector, and regional organizations. County, city, and district advisory groups guided the plan development process.

The County Steering Committee included representatives from the cities of Gates, Halsey, Harrisburg, Lebanon, Lyons, Millersburg, Scio, Sodaville, Sweet Home and Tangent, and the Lyons Rural Fire District. Partner organizations that participated included Consumers Power, Inc., a privately owned not-for-profit rural electric cooperative, the Linn Benton Community College, Albany Fire Department, and the City of Mill City. (See Acknowledgements, above, for participant information.)

44 CFR 201.6(c)(1) – Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

The Linn County Planning Director and Linn County Emergency Manager convened the planning process for Linn County. The Steering Committee formally met seven times to discuss and revise the Plan, with additional meetings organized by participating jurisdictions to gather feedback internally. Steering Committee members contributed data and maps, and reviewed and updated the community profile, risk assessment, action items, and implementation and maintenance plan. Although members of the Steering Committee represent the public to some extent, the public had opportunities to provide input and feedback about the plan and will continue to do so throughout the implementation and maintenance period. The planning and public engagement process is further discussed in Section 4, Plan Implementation and Maintenance, and Appendix A: Planning and Public Process. Linn County is dedicated to directly involving the public in the continual review and update of the Natural Hazards Mitigation Plan.

How is the Plan Organized?

Each volume of the NHMP provides specific information and resources to assist readers in understanding the hazard-specific issues facing county and city residents, businesses, and the environment. Combined, the sections work together to create a mitigation plan that furthers the community's mission to reduce or eliminate long-term risk to people and their property from hazards and their effects. The Plan's structure enables readers to locate the section(s) of interest to them.

Volume I: Basic Plan

Section 1: Introduction

The Introduction briefly reviews natural hazards mitigation planning and explains why it is important, and describes federal requirements and the policy framework for natural hazards planning in Oregon. It discusses the countywide mitigation planning efforts and the methodology used to develop the NHMP.

Section 2: Risk Assessment

44 CFR 201.6(c)(2) – A Risk Assessment that provides the factual basis for activities proposed in the strategy…

Section 2 provides the factual basis for the mitigation strategies contained in Section 3. The Risk Assessment allows readers to gain an understanding of each jurisdiction's vulnerability and resilience to natural hazards. Additional information is included within Appendix B: Community Profile, which contains an overall description of Linn County and the cities of Gates, Halsey, Harrisburg, Lebanon, Lyons, Millersburg, Scio, Sodaville, Sweet Home and Tangent, and the Lyons Rural Fire District. Highlights of each jurisdiction's vulnerabilities are included in Volume II, City and District Addenda.

A hazard summary is provided for each of the hazards addressed in the Plan, shown in Table 1-1, including history, location, extent, vulnerability, impacts, and probability. The Steering Committee added several new hazards, underlined below, and further refined others by separating out specific hazards of concern, shown in italics below.

Table 1-1. Linn County Hazard Identification with Changes

Linn County 2025 NHMP update
Dam Failure
Droughts
Earthquakes (Crustal and Cascadia)
Extreme Heat
Floods
Landslides and Avalanches
Smoke/Poor Air Quality
Volcanoes
Wildfires
Windstorms/Tornadoes
Winter Storms/Ice Storms

Additionally, this section provides information on the jurisdictions' participation in the National Flood Insurance Program (NFIP).

By identifying and understanding the relationship between natural hazards, vulnerable systems, and existing capacity, Linn County is better equipped to identify and implement actions aimed at reducing the overall risk to natural hazards.

Section 3: Mitigation Strategy

This section documents the Plan's mission, goals, and mitigation strategy actions that help to guide future activities aimed at reducing risk and preventing loss from natural hazards. Based on the mission and goals, specific action items have been created. Action items are detailed recommendations for activities that the County, cities, district, residents, and others can engage in to reduce risk. The mitigation strategy is informed by the risk assessment, including community sensitivity and resilience factors, further described in Section 2 and Volume II: City and District Addenda.

44 CFR 201.6(c)(3)(i) – A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

44 CFR 201.6(c)(3)(ii) – A section that identifies and analyzes a comprehensive range of specific mitigation actions…

Section 4: Plan Implementation and Maintenance

This section provides information on how the Plan will be implemented and maintained. It describes the process for prioritizing projects and includes a schedule for monitoring and evaluating the NHMP annually and producing a plan revision every five years. This section also describes how the communities will integrate public participation throughout the plan maintenance process. This section also provides information about the process for review, OEM and FEMA approval, and local adoption of the MJ-NHMP.

44 CFR 201.6(c)(3)(iii) – An action plan describing how the actions… will be prioritized, implemented and administered…

44 CFR 201.6(c)(4) – A plan maintenance process…

Accomplishing NHMP goals and actions depends on regular participation of Steering Committee members and adequate support from county, city, and district leadership. Thorough familiarity with this Plan will result in the efficient and effective implementation of appropriate mitigation activities and a reduction in the risk and the potential for loss from future natural hazard events.

44 CFR 201.6(c)(5) – Documentation that the plan has been formally adopted by the governing body of the jurisdiction…

44 CFR 201.6(d) – Plan review [process]...

Volume II: Jurisdictional Addenda

Volume II of the Plan contains the city and special district addenda developed through this multi-jurisdictional planning process. These addenda serve as the Natural Hazard Mitigation Plan in combination with the information in Volume I as referenced for each of the following jurisdictions:

- City of Gates
- City of Halsey
- City of Harrisburg
- City of Lebanon
- City of Lyons
- City of Millersburg
- City of Scio
- City of Sodaville
- City of Sweet Home
- City of Tangent
- Lyons Rural Fire District

The City of Gates is on the border of Linn and Marion counties and participated in the Marion County MJ-NHMP during the 2017 update planning process. This is the first time the City has created an addendum in the Linn County MJ-NHMP.

The City of Sweet Home is incorporating its current effective stand-alone NHMP into this 2025 update of the Linn County Multi-Jurisdictional Natural Hazard Mitigation Plan. Millersburg participated in the Linn County MJ-NHMP planning process for the first time during this 2023-2025 update.

The Lyons RFD is incorporating its current effective NHMP into this 2025 update of the Linn County Multi-Jurisdictional Natural Hazard Mitigation Plan. The current Lyons RFD NHMP is effective until March 9, 2026, and will remain in effect until the Lyons RFD adopts the updated Linn County MJ-NHMP.

The five-year update cycle will be the same for the district, all of the cities, and the county.

The City of Albany has a stand-alone NHMP. The cities of Brownsville and Waterloo declined to participate in this MJ-NHMP update due to lack of capacity. The cities of Idanha and Mill City are included in the Marion County MJ-NHMP.

Volume III: Appendices

The following appendices are designed to provide the users of the Linn County MJ-NHMP with additional information to assist them in understanding the contents of the Plan and provide them with resources to assist with plan implementation.

Appendix A: Planning and Public Process

This appendix provides an overview of the plan update process, including a summary of major changes made to the MJ-NHMP. It also summarizes the Steering Committee's role and public outreach conducted by the county and participating jurisdictions, including a summary of input gained through the community survey.

Appendix B: Community Profile

The community profile describes the county and participating cities from a number of perspectives in order to help define and understand the region's sensitivity and resilience to natural hazards. The information in this section represents a snapshot in time of the current sensitivity and resilience factors in the region when the plan was updated.

Appendix C: Economic Analysis of Natural Hazard Mitigation Projects

This appendix describes the FEMA requirements for benefit cost analysis in natural hazards mitigation, as well as various approaches for conducting economic analysis of proposed mitigation activities.

Appendix D: Grant Programs and Resources

This appendix lists state, federal, and philanthropic resources and programs by hazard.

Appendix E: DOGAMI Multi-Hazard Risk Assessment Report, Linn County, OR

Appendix F: OCCRI Future Climate Projections Report, Linn County, OR

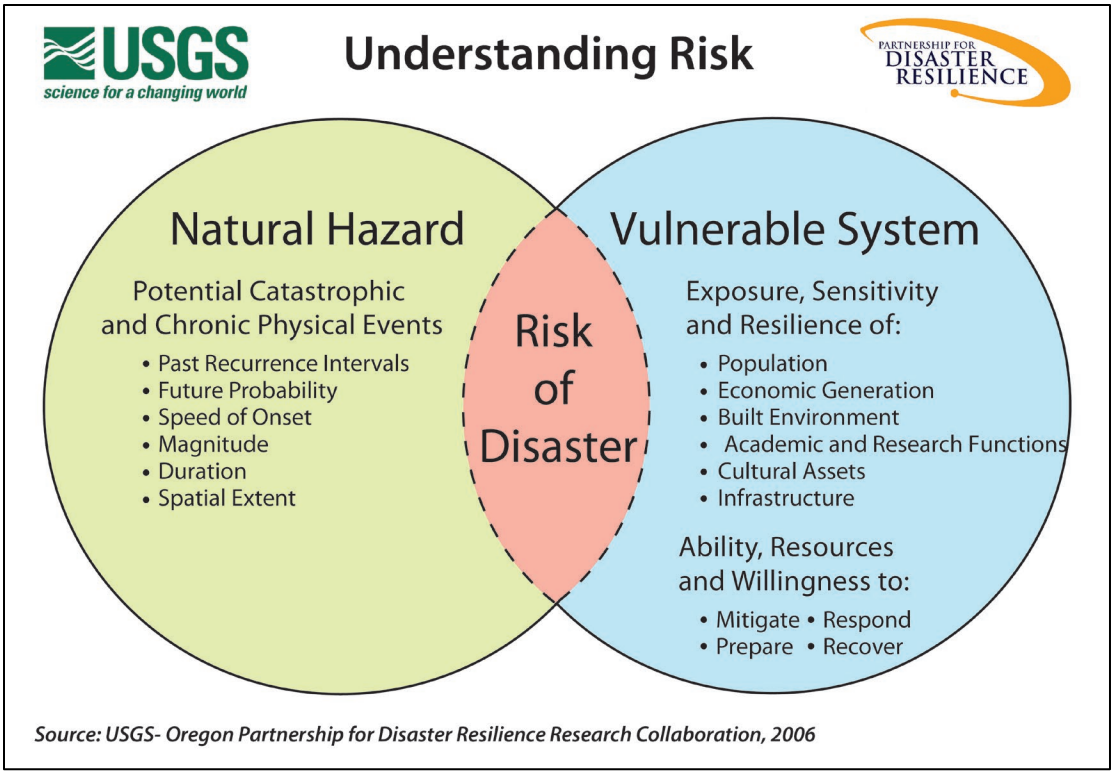
Appendix G: FEMA Plan Review Tool and Resolutions

SECTION 2:
RISK ASSESSMENT

This section of the NHMP addresses 44 CFR 201.6(b)(2) - Risk Assessment. The Risk Assessment applies to Linn County, the Cities of Gates, Halsey, Harrisburg, Lebanon, Lyons, Millersburg, Scio, Sodaville, Sweet Home, and Tangent, and the Lyons Rural Fire District. City and district specific information is called out where relevant. In addition, this chapter can assist with addressing Oregon Statewide Planning Goal 7 – Areas Subject to Natural Hazards.

The information presented below, along with community characteristics presented in Appendix B: Community Profile, is used to inform the risk reduction actions identified in Section 3: Mitigation Strategy. The risk assessment process is graphically depicted in Figure 2-1 below. Ultimately, the goal of hazard mitigation is to reduce the area where hazards and vulnerable systems overlap.

Figure 2-1. Understanding Risk



Source: Oregon Partnership for Disaster Resilience.

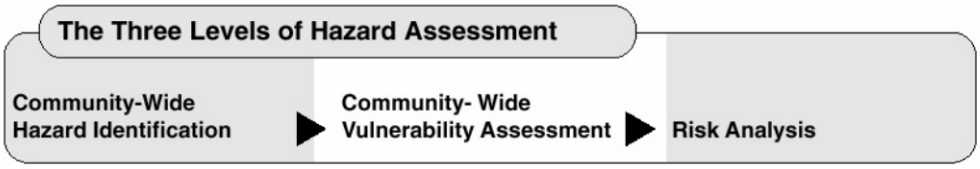
What is a Risk Assessment?

A risk assessment consists of three phases: hazard identification, vulnerability assessment, and risk analysis.

- **Phase 1:** Identify hazards that can impact the jurisdiction. This includes an evaluation of potential hazard impacts – type, location, extent, etc.
- **Phase 2:** Identify important community assets and system vulnerabilities. Example vulnerabilities include people, businesses, homes, roads, historic places and drinking water sources.
- **Phase 3:** Evaluate the extent to which the identified hazards overlap with, or have an impact on, the important assets identified by the community.

The following figure illustrates the three-phase risk assessment process.

Figure 2-2. Three Phases of Risk Assessment



Source: Planning for Natural Hazards: Oregon Technical Resource Guide, 1998

This three-phase approach to developing a risk assessment should be conducted sequentially because each phase builds upon data from prior phases. However, gathering data for a risk assessment need not occur sequentially.

Hazard Identification

Linn County re-evaluated the natural hazards that affect the county in 2024. The Steering Committee named Extreme Heat as a hazard that had not previously been identified in the NHMP and the effect of Smoke and Poor Air Quality was identified as a hazard separate from but related to Wildfire hazards. The Steering Committee separated Severe Weather into Winter Storm/Ice Storm and Windstorm/Tornado due to the differences in vulnerability and mitigation strategy for these types of severe weather. The hazard of Avalanche was added to the Landslide hazard because of the potential for avalanches to affect people and property like landslides do. Dam Failure was added to the hazards assessed in this plan due to FEMA requirements for inclusion of this hazard and the presence of several High Hazard Potential Dams in Linn County.

The Steering Committee identified twelve natural hazards (when counting each type of earthquake separately) that could have an impact on the county and each of the participating jurisdictions. Summary information for each hazard is presented below; additional information pertaining to the types and characteristics of each hazard is available in the 2020 State of Oregon Natural Hazard Mitigation Plan (Oregon NHMP) Region 3 Risk Assessment.

Table 2-1 lists the hazards identified in the county in comparison to the hazards identified in the Oregon NHMP for the Mid/Southern Willamette Valley (Region 3), which includes Linn County.

Table 2-1. Linn County Hazard Identification

Linn County 2025 NHMP update	State of Oregon NHMP, 2020; Region 3: Mid/Southern Willamette Valley
Dam Failure	
Droughts	Droughts
Earthquakes (Crustal and Cascadia)	Earthquakes
Extreme Heat	Extreme Heat
Floods	Floods
Landslides and Avalanches	Landslides
Smoke & Poor Air Quality	
Volcanoes	Volcanoes
Wildfires	Wildfires
Windstorms/Tornadoes	Windstorms
Winter Storms/Ice Storms	Winter Storms

Source: Linn County NHMP Steering Committee (2024) and State of Oregon NHMP, Region 3: Mid/ Southern Willamette Valley (2020)

The following subsections briefly describe relevant information for each hazard. For additional background on the hazards, vulnerabilities, and general risk assessment information for hazards in the Mid/Southern Willamette Valley (Region 3) refer to the 2020 Oregon NHMP or the most recent update.

Dam Failure

Significant Changes Since Previous Plan:

Dam Failure is being addressed separately for the first time in this plan update.

The Oregon Water Resources Department (OWRD) is the state authority for dam safety with specific authorizing laws and implementing regulations. Oregon's dam safety laws were re-written in HB 2085 which passed through the legislature and was signed by Governor Brown in 2019. This law became operative on July 1, 2020.

OWRD coordinates on, but does not directly regulate, the safety of dams owned by the United States, or most dams used to generate hydropower. OWRD is the Oregon Emergency Response System contact in the event of a major emergency involving a state-regulated dam, or any dam in the state if the regulating agency is unknown. The program also coordinates with the National Weather Service and the Oregon Department of Emergency Management (OEM) on severe flood potential that could affect dams and other infrastructure.

The OWRD has been striving to inspect over 900 dams under its jurisdiction with recommendations sent to dam owners. At times, urgent dam safety notices are needed, and for uncooperative dam owners' failure to maintain the dam may lead to an administrative hearing and formal order. The program meets the minimum FEMA standard for Emergency Action Plans and sometimes exceeds FEMA guidance for dam safety inspections on schedule and for condition classification.

Characteristics

Oregon's statutory size threshold for dams to be regulated by OWRD is at least 10 feet high and storing at least 3 million gallons of water. An additional 12,000 or so dams that fall below that threshold have water right permits for storage from OWRD. As of December 2019, there were 945 state-regulated dams and another 252 federally regulated dams that met Oregon's statutory size threshold for regulation by OWRD. The largest dams are under federal ownership or regulation.

Dam Hazard Ratings: Oregon's new dam safety laws were developed considering the joint Association of State Dam Safety Officials and FEMA's Model State Dam Safety Program. Oregon follows national guidance for assigning hazard ratings to dams and for the contents of Emergency Action Plans, which are now required for all dams rated as "high hazard." Each dam is rated according to the anticipated impacts of its potential failure. The State has adopted these definitions (ORS 540.443–491) for state-regulated dams:

- "High Hazard" means loss of life is expected if the dam fails.
- "Significant Hazard" means loss of life is not expected if the dam fails, but extensive damage to property or public infrastructure is.
- "Low Hazard" is assigned to all other state-regulated dams.
- "Emergency Action Plan" means a plan that assists a dam owner or operator, and local emergency management personnel, to perform actions to ensure human safety in the event of a potential or actual dam failure.

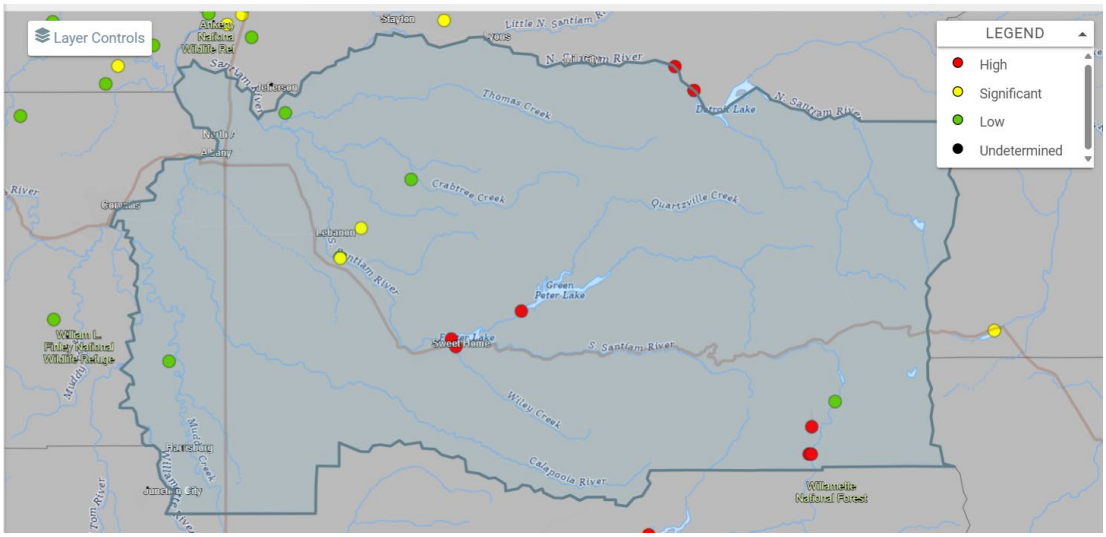
OWRD conducts hazard rating reviews as its limited resources permit. Correction of hazard ratings is a program priority, and therefore hazard ratings can and do change. Ratings may change for a number of reasons. For example, a dam's original rating may not have been based on current inundation analysis methodologies, or new development may have changed potential downstream impacts. Since 2013, OWRD has formally reviewed the hazard ratings of over 25 state-regulated dams, resulting in the ratings of about 16 being elevated to high hazard status. Federal agencies conduct similar analyses to determine hazard ratings of federally regulated dams.

Location and Extent

OWRD has inventoried all dams located in Oregon and Linn County. There are seven dams that are categorized as High Hazard. Six of these are federally regulated dams. Three dams, Detroit Dam, Green Peter Dam, and Foster Dam, are owned and operated by the US Army Corps of Engineers, Portland District. Green Peter Dam and the Foster Dam are located on the Middle Santiam and the Santiam Rivers respectively, and the Detroit Dam is located on the North Santiam River along the Marion and Linn County border. Big Cliff Dam, located in Marion County, is also categorized as a High Hazard Potential Dam and owned and operated by the U.S.

Army Corps of Engineers, and is located downstream from the Detroit Dam on the North Santiam River. Three others are owned by the Eugene Water and Electric Board (EWEB), including Smith Dam, Trail Bridge Dam, and Trail Bridge Saddle Dike, and are also federally regulated. All of these EWEB dams are used for hydroelectric power generation and are regulated by the Federal Energy Regulatory Commission.

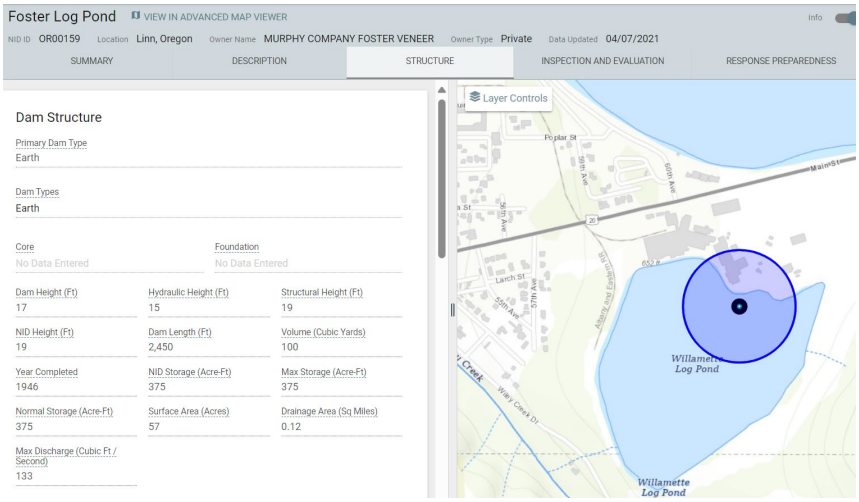
Figure 2-3. National Inventory of Dams, Locations in Linn County, Oregon



Source: National Inventory of Dams, accessed February 2025, https://nid.sec.usace.army.mil/#/.

One High Hazard Potential Dam, the Foster Log Pond Dam, is regulated by the State of Oregon. It is owned by a private company, Murphy Company Foster Veneer, and is located within the Sweet Home city limits. The Foster Log Pond dam is an earthen dam constructed in 1946. It is 19 feet high and stores 375-acre feet of water. It is inspected by the State of Oregon on an annual basis. The most recent inspection available on the National Inventory of Dams (NID) was conducted in September 2020 and indicated the condition of the dam was fair. No inundation map was available for this dam.

Figure 2-4. NID Structure Details for Foster Log Pond Dam



Source: National Inventory of Dams, accessed July 2024, https://nid.sec.usace.army.mil/#/.

Additional details on all dams identified in the NID are provided in Appendix B: Community Profile.

History

Oregon has records of at least 55 dam failures in the State. Many of these failures had very little or no impact on people, structures, or properties.

Probability Assessment

Under normal loading conditions dams are generally at very low risk of failure. Specific events are associated with most dam failures. Events that might cause dams to fail include:

- An extreme flood that exceeds spillway capacity and causes an earthen dam to fail,
- Extended high-water levels in a dam that has no protection against internal erosion,
- Movement of the dam in an earthquake, and
- A large rapidly moving landslide impacting the dam or reservoir.

Based on the participants' background and experience in Linn County using the OEM-FEMA Risk Assessment methodology the NHMP Steering Committee assessed the **probability of experiencing a dam failure as low,** meaning one incident is likely within a 75–100-year period. The Steering Committee members ranked probability of dam failure 2.6 out of 10 indicating a probability of one event every 75-100 years.

Vulnerability and Impacts

Landslides are a significant hazard in many parts of Oregon and some dams are constructed on landslide deposits. Though not common, a large and rapidly moving landslide or debris flow may generate a wave that can overtop a dam, causing significant flooding, especially if it causes a dam to fail.

Wildfires may increase the risk of debris flows, though wildfire generated debris flows are typically on the smaller size scale. Wildfires and windstorms can also result in large woody debris that can block spillways, also a risk to dam integrity. Oregon will be evaluating both landslide and wildfire risks during its High Hazard Potential Dam grant funded risk assessments of dams currently eligible for the program.

Most of the largest dams, especially those owned or regulated by the Federal Government, are designed to safely withstand these events and have been analyzed to show that they will.

However, there are a number of dams where observations and sometimes analysis indicate a deficiency that may make those dams susceptible to one or more of the events. The majority of State-regulated dams do not have a current risk assessment or analysis and safe performance in these events is uncertain.

Failures of some dams can result in loss of life, damage to property, infrastructure, and the natural environment. The impacts of dam failures range from local impacts to the dam owner's property and waters below the dam to community destruction with mass fatalities. The 1889 Johnston Flood in Pennsylvania was caused by a dam failure and resulted in over 2,000 lives lost. Oregon's first dam safety laws were developed in response to the St. Francis dam failure in

California in 1928. That failure was attributed to unsafe design practice, and because of this about 500 people perished. In 2006, a dam owner filled in the spillway of a dam on the island of Kauai causing dam failure that killed seven people. This dam had no recent dam safety inspections because the hazard rating was incorrect.

Where a dam's failure is expected to result in loss of life downstream of the dam, an Emergency Action Plan (EAP) must be developed. The EAP contains a map showing the area that would potentially be inundated by floodwaters from the failed dam. These dams are often monitored so that conditions that pose a potential for dam failure are identified to allow for emergency evacuations.

The Foster Log Pond Dam has an EAP; however, the date of last revision was not indicated in the NID database. The most recently reported inspection available on the National Inventory of Dams was conducted in September 2020 and indicated the condition of the dam was fair. However, no inundation map was available for this dam. Thus, it is difficult to ascertain the potential vulnerability of and impacts to community assets from failure of this dam.

Based on the participants' background and experience in Linn County using the OEM-FEMA Risk Assessment methodology, the NHMP Steering Committee assessed the **vulnerability to a dam failure as moderate** with a score of 6.8 out of 10 meaning that 1% - 10% of the population is likely to be affected.

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley, of the Oregon NHMP (2020) or the most recent five-year update.

Drought

Significant Changes Since Previous Plan:

The Linn County Steering Committee ranked both vulnerability and probability of drought as "moderate." This is an increase from these rankings in the previous plan. Historical data have been updated and the results of the Future Climate Projections Report, Linn County, Oregon, prepared by the Oregon Climate Change Research Institute, have been incorporated.

Oregon Revised Statute Chapter 536 identifies authorities available during a drought. To trigger specific actions from the Water Resources Commission and the Governor, a "severe and continuing drought" must exist or be likely to exist. Oregon relies upon two inter-agency groups to evaluate water supply conditions and to help assess and communicate potential drought-related impacts, the Water Supply Availability Committee (WSAC) and the Drought Readiness Council.

The WSAC is a technical committee chaired by the OWRD. The WSAC provides the scientific foundation that decision-makers need to identify and respond appropriately to drought. The Committee consists of state and federal science and emergency preparedness agencies.

The WSAC meets early and often throughout the year to evaluate the potential for drought conditions. If drought development is likely, monthly meetings occur shortly after the release of federal Natural Resources Conservation Service (NRCS) Water Supply Outlook reports for that year. The following indicators are used by the WSAC for evaluating drought conditions:

- Snowpack
- Precipitation
- Temperature anomalies
- Long range temperature outlook
- Long range precipitation outlook
- Current stream flows and behavior
- Spring and summer streamflow forecasts
- Ocean surface temperature anomalies (El Niño and La Niña)
- Storage in key reservoirs
- Soil and fuel moisture conditions
- NRCS Surface Water Supply Index.

The second inter-agency group, the Drought Readiness Council (DRC), is co-chaired by OWRD and OEM. The DRC reviews local requests for assistance and makes recommendations to the Governor regarding the need for state drought declarations. The Council consists of state agencies with natural resources management, public health, or emergency management expertise.

Characteristics

A drought is a period of drier than normal conditions. Drought occurs in virtually every climatic zone, but its characteristics vary significantly from one region to another. Drought is a temporary condition; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate. The extent of drought events depends upon the degree of moisture deficiency and the duration and size of the affected area. Typically, droughts occur as regional events and often affect more than one city and county.

Location and Extent

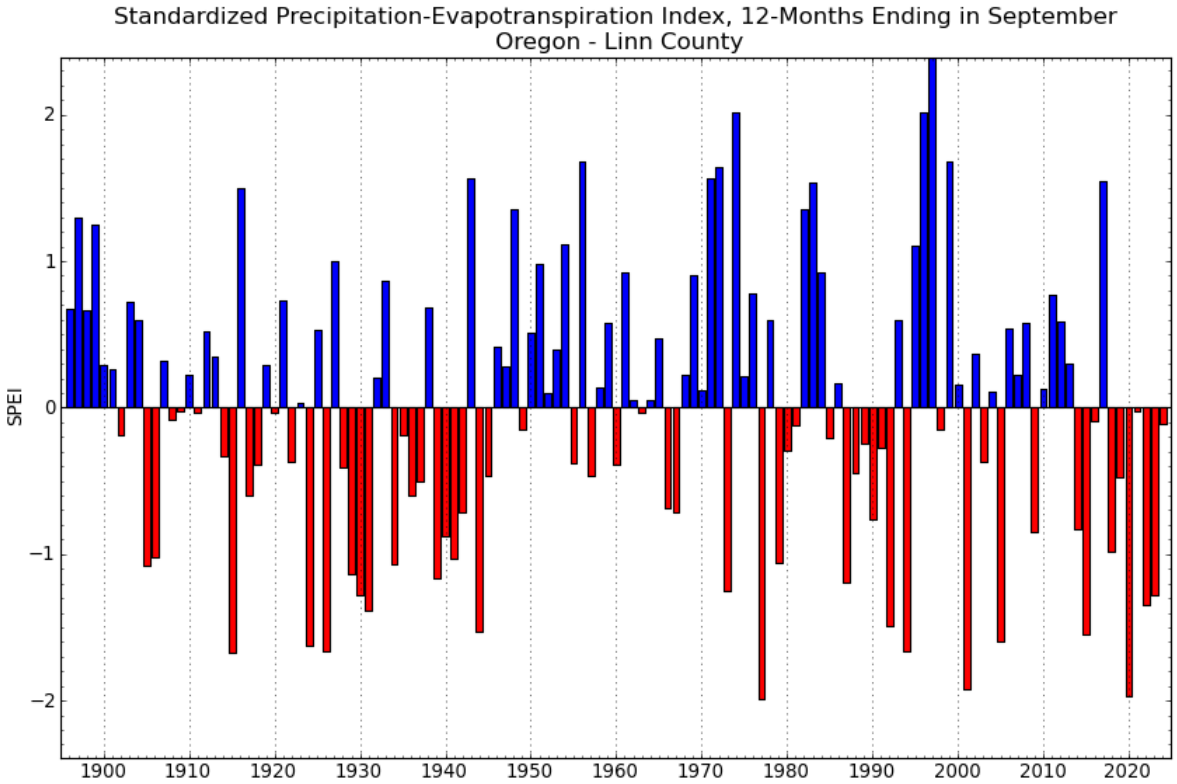
Droughts occur in every climate zone and can vary from region to region. Drought may occur throughout Linn County and may have profound effects on the economy, particularly the agricultural and hydro-power sectors. Drought is typically measured in terms of water availability in a defined geographical area. It is common to express drought with a numerical index that ranks severity. Most federal agencies use the Palmer Method, which incorporates precipitation, runoff, evaporation and soil moisture. However, the Palmer Method does not incorporate snowpack as a variable. Therefore, it is not believed to provide a very accurate indication of drought conditions in Oregon and the Pacific Northwest.

The Standardized Precipitation Evapotranspiration Index (SPEI) is another method for analyzing drought conditions. It is an extension of the widely used Standardized Precipitation Index (SPI) and is designed to consider both precipitation and potential evapotranspiration in determining drought. The dimensionless SPEI is a key quantitative metric for assessing the occurrence and severity of meteorological and hydrological drought. It compares the net water balance between precipitation and potential evapotranspiration between a recent period of time and a historical period.[2]

[2] Fifth Oregon Climate Assessment, 2021, Oregon Climate Change Research Institute, https://oregonstate.app.box.com/s/7mynjzhda9vunbzqib6mn1dcpd6q5jka

SPEI allows for comparison of drought severity in different locations and times and for identification of different drought types, including consideration of the role of temperature in drought assessment. The 12-month SPEI is a reliable predictor of annual streamflow in the Northwest and water levels in lakes and reservoirs.[3] The SPEI employs a Drought Severity Scale where 0 represents normal and drought is represented by negative numbers (-1 to -1.49 = moderate drought; -1.5 to -1.99 = severe drought; -2.0 or less = extreme drought). Figure 2-5 shows the history of SPEI from 1895 to 2024 for Linn County.

Figure 2-5. SPEI 24 for Linn County, 12-months Ending in September (1895-2024)



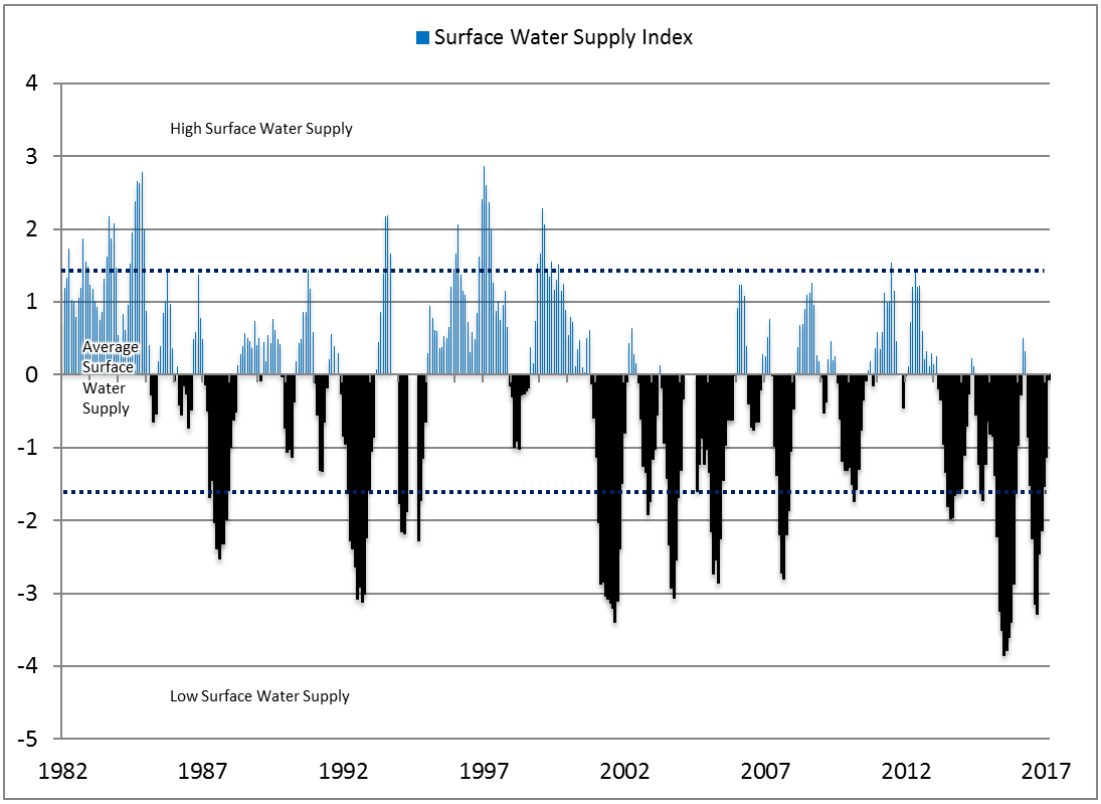
Source: West Wide Drought Tracker, accessed December 2024; WWDT

The previous Linn County NHMP cited another measure of drought, the Surface Water Supply Index (SWSI) from the Natural Resources Conservation Service, which is an index of current water conditions throughout the state. The index uses parameters derived from snow, precipitation, reservoir, and stream flow data. This index is no longer provided for Oregon counties however the data was retained in this NHMP update in order to provide continuity. Figure 2-6, below, shows the monthly history of SWSI values from February 1982 to March 2017 for the Willamette Basin, which includes Linn County. Research shows that the periods of drought have fluctuated; recent moderate drought periods occurred in 1987, 1992, 1994, 2001, 2003, 2005, 2015, and 2016.

[3] Ibid.

Notably, the Governor signed a drought declaration for Linn County covering the period from August 25, 2015 – December 31, 2015; a period which came close to reaching the severe drought SWSI classification.[4]

Figure 2-6. SWSI Values for the Willamette Basin (1982-2016)



Source: Department of Agriculture-Natural Resources Conservation Service, "Surface Water Supply Index, Willamette Basin" www.or.nrcs.usda.gov. Accessed March 2017.

History

Drought conditions are not uncommon in Linn County, though there are no records of severe drought or damage from drought. Several recent drought events and two previously omitted drought events have been added to the hazard history since the previous plan, as shown in *italics* below:

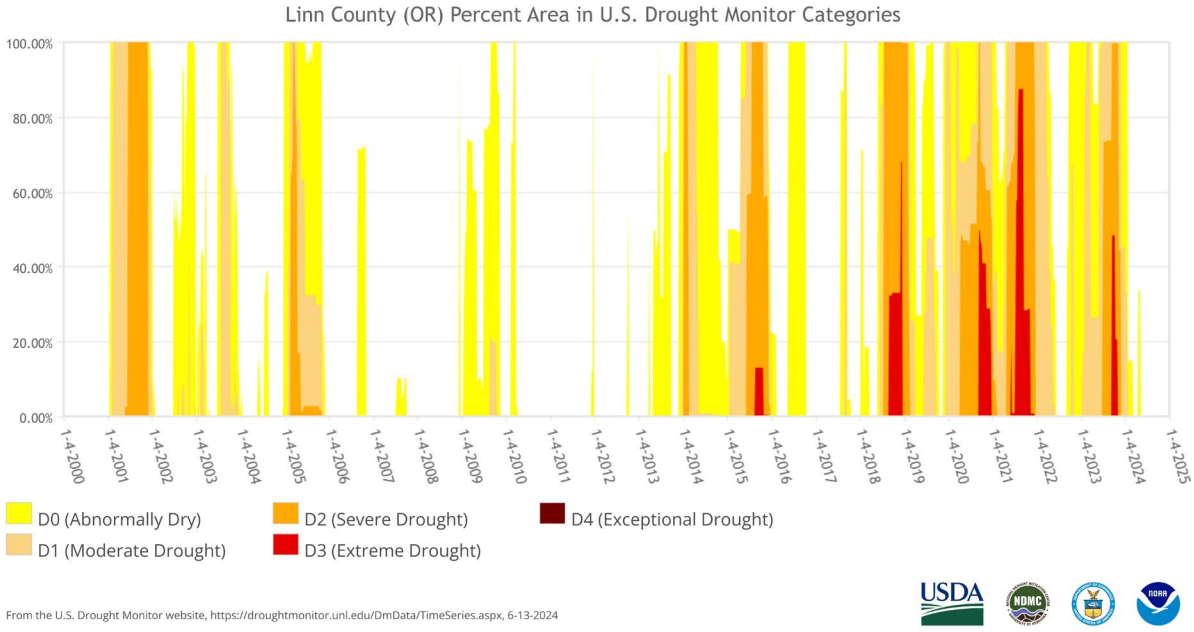
- **1904-1905:** A statewide drought period of about 18 months
- **1917-1931:** A very dry period throughout Oregon, punctuated by brief wet spells in 1920-21 and 1927
- **1939-1941:** A three-year intense drought in Oregon
- **1976-1981:** Intense drought in western Oregon; 1976-1977 single driest year of century (eclipsed only by 2015 water-year)
- **1985-1997:** Generally a dry period, capped by statewide droughts in 1992 and 1994

[4] Oregon Water Resources Department, Public Declaration Status Report, http://apps.wrd.state.or.us/apps/wr/wr_drought/declaration_status_report.aspx.

- ***1992:*** *Formal Governor Declared Determination of State of Drought includes Linn County*
- **2000-2001:** Klamath drought intensifies; low snowpack in mountains worsens conditions. Due to lack of water Bonneville Power Administration asked some consumers (industrial and residential) to limit power use
- ***2005:*** *Due to water rationing some farmers cut back production of certain crops including wheat and hay*
- ***2015:*** *Federal Drought Declaration due low snow pack levels, and low water conditions*
- ***2018:*** *Portions of Linn County experienced Extreme Drought*
- ***2021:*** *Portions of Linn County experienced Extreme Drought*
- ***2022:*** *Portions of Linn County experienced Extreme Drought*
- ***2023:*** *Portions of Linn County experienced Extreme Drought*

A graphical representation of the area within Linn County experiencing the range of drought conditions as provided by the U.S. Drought Monitor is below.

Figure 2-7. U.S. Drought Monitor Percent Area of Linn County 2000-2024 (February)



El Niño and La Niña

El Niño Southern Oscillation (ENSO) weather patterns, which include El Niño and La Niña, are climate patterns in the Pacific Ocean that can affect weather worldwide. During El Niño periods, the warmer waters cause the Pacific jet stream to move south of its neutral position. With this shift, areas in the northern U.S. and Canada are dryer and warmer than usual. In Oregon, this shift results in reduced precipitation and warmer temperatures, normally experienced several months after the initial onset of the El Niño, increasing the frequency and severity of drought. These periods tend to last nine to twelve months, after which surface temperatures begin to trend back towards the long-term average. El Niño periods tend to develop between March and June, and peak from December to April.

La Niña has the opposite effect of El Niño. During La Niña events, trade winds are even stronger than usual, pushing more warm water toward Asia. Off the west coast of the Americas, upwelling increases, bringing cold, nutrient-rich water to the surface. These cold waters in the Pacific push the jet stream northward. This tends to lead to drought in the southern U.S. and heavy rains and flooding in the Pacific Northwest and Canada.

ENSO generally follows a two to seven-year cycle, with El Niño or La Niña periods occurring every three to five years. However, the cycle is highly irregular and no set pattern exists. According to the National Oceanic and Atmospheric Administration (NOAA), El Niño weather patterns were present was during 1998, 2003, 2007, 2010, and 2016. Neutral conditions persisted between 2017 to 2020. La Niña conditions occurred during 2021 and 2022.[5]

Probability Assessment

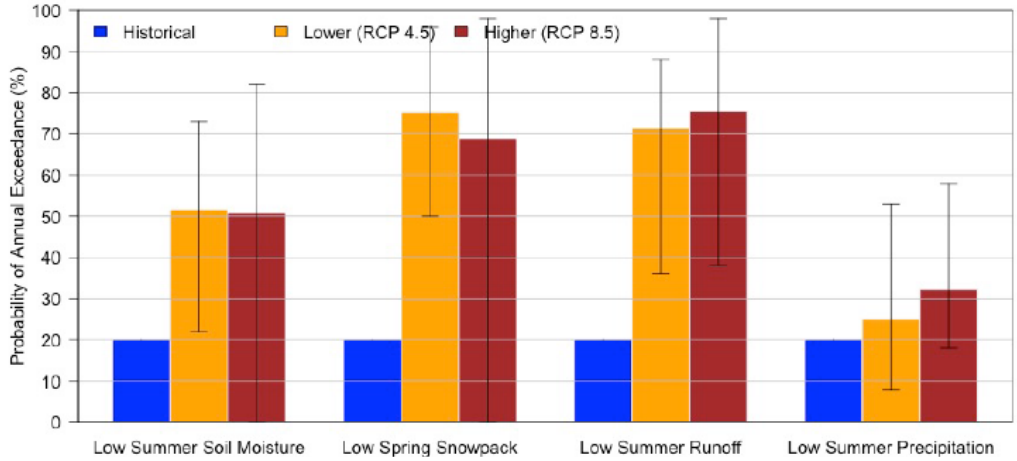
Droughts are not uncommon in the State of Oregon, nor are they just an "east of the mountains" phenomenon. They occur in all parts of the state, in both summer and winter. Oregon's drought history reveals many short-term and a few long-term events. The average recurrence interval for severe droughts in Oregon is somewhere between 8 and 12 years.

In Oregon, future regional climate changes include increases in temperature around 0.2-1°F per decade in the 21st Century, along with warmer and drier summers, and some evidence that extreme precipitation will increase in the future. Increased droughts may occur in the Willamette Valley under various climate change scenarios as a result of various factors, including reduced snowpack, rising temperatures, and likely reductions in summer precipitation. Climate models suggest that as the region warms, winter snow precipitation will likely shift to higher elevations and snowpack will be diminished as more precipitation falls as rain altering surface flows.

The Oregon Climate Change Research Institute (OCCRI) analyzed potential impacts of future climate conditions on natural hazards. The OCCRI Future Climate Projections Report for Linn County, provided as background for this NHMP and included in Appendix F, presents projected changes in four variables indicative of seasonal drought: low spring (April 1) snowpack (snow drought), low summer (June–August) soil moisture from the surface to 55 inches below the surface (agricultural drought), low summer runoff (hydrological drought), and low summer precipitation (meteorological drought), shown in Figure 2-8. Drought, as represented by these variables, is projected to become more frequent in Linn County by the 2050s.

[5] psl.noaa.gov/enso/past_events.html

Figure 2-8. Projected Future Drought in Linn County



Source: OCCRI Future Climate Projections Report, Linn County, Oregon, September 2023.

Based on the background and experience of Linn County NHMP Steering Committee members, the group assessed the **probability of experiencing a locally severe drought on the high end of the "moderate" range** with a score of 7.5 out of 10 meaning one incident is likely within the next 35 to 75-year period. *This rating has increased from the previous plan, which rated the probably of drought as "moderate" with a score of 5.0.*

Vulnerability and Impacts

The environmental and economic consequences of drought can be significant, especially for the agricultural sector. Drought also increases the probability of wildfires. Drought can affect all segments of Linn County's population, particularly those employed in water-dependent activities (e.g., agriculture, hydroelectric generation, recreation, etc.). Also, domestic water users may be subject to stringent conservation measures (e.g., rationing) as per the county's water management plan. People could also be faced with significant increases in electricity rates due to strains on hydroelectric generation from competing uses.

Factors included in assessing drought risk include agricultural practices, including crop types and varieties grown, soil types, topography, and water storage capacity. When sufficient data is collected for hazard identification and vulnerability assessment, a risk analysis can be completed.

A vulnerability assessment that describes the number of lives or amount of property exposed to elements of drought has not yet been conducted for Linn County due to resource limitations. There is insufficient asset, development, and vulnerability data available to estimate potential dollar losses and other impacts to vulnerable structures, facilities, and community assets at this time. The collection and analysis of appropriate data would serve as an important mitigation item to be completed in the future, resources permitting. Needed data includes the location and ranking of hazard areas; the types and numbers of buildings, infrastructure and critical facilities; and the location, construction, materials, and replacement value of buildings, infrastructure and critical facilities in hazard areas. Given current available data, it is beyond the capability of Linn County to assess these broader vulnerabilities and impacts at this time. The County has added a new multi-hazard action item, MH-14, to evaluate vulnerability of and impacts to community assets from drought, where feasible.

Based on the knowledge and experience of Steering Committee members, the vulnerability to drought has increased since the previous plan. The Steering Committee members **rated Linn County's vulnerability to drought as "moderate"** with a score of 5.9 out of 10 meaning that 1% - 10% of the population is likely to be affected. *This is an increase in the assessment of vulnerability since the previous plan.*

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley, of the Oregon NHMP (2020) and future updates.

Earthquake

Significant Changes Since Previous Plan:

The Earthquake Hazard section updated with analysis from the Oregon Department of Geology and Mineral Industries that assesses losses from two earthquake scenarios.

The Steering Committee's assessment of the Probability factor for a Cascadia Subduction Zone (CSZ) earthquake was revised to "moderate" from "high" and for a crustal earthquake remained "moderate." The Steering Committee's assessment of Vulnerability rated Vulnerability as "moderate" for both earthquake scenarios, whereas the previous NHMP rated CSZ earthquake Vulnerability as "high" and Vulnerability to a crustal earthquake event as "moderate."

Characteristics

The Pacific Northwest in general is susceptible to earthquakes from four sources: 1) the offshore Cascadia Subduction Zone (CSZ); 2) deep intraplate events within the subducting Juan de Fuca Plate; 3) shallow crustal events within the North American Plate, and 4) earthquakes associated with volcanic activity. All types of earthquakes in the region have some tie to the subducting, or diving, of the dense, oceanic Juan de Fuca Plate under the lighter, continental North American Plate. There is also a link between the subducting plate and the formation of volcanoes some distance inland from the offshore subduction zone.

The Department of Geology and Mineral Industries (DOGAMI) examined earthquake shaking and ground failure hazards produced from two earthquake scenarios using Hazards U.S. Multi-Hazard methodology (HAZUS – MH), a model developed by FEMA, to encapsulate the range of damages from two very different kinds of earthquakes: a nearby crustal earthquake focused on the Turner and Mill Creek fault and a more distant and very large magnitude earthquake focused on the CSZ. This analysis is summarized in this section and the DOGAMI Multi-Hazard Risk Report for Linn County is provided in Appendix E.

Cascadia Subduction Zone

Paleoseismic studies along the Oregon coast indicate that the state has experienced seven CSZ events possibly as large as magnitude-9 (M9) in the last 3,500 years. These events are estimated to have an average recurrence interval between 500 and 600 years, although the time interval between individual events ranges from 150 to 1,000 years. The last CSZ event occurred approximately 300 years ago. Scientists estimate the chance in the next 50 years of a great

subduction zone earthquake is between 10 and 20 percent, assuming that the recurrence is on the order of 400 +/- 200 years.

New research from Oregon State University suggests that the CSZ has at least four segments that sometimes rupture independently of one another. M9 ruptures affecting the entire subduction zone have occurred 19 times in the past 10,000 years. Over that time, shorter segments have ruptured farther south in Oregon and Northern California, producing M8 quakes. As such, the risks of a subduction zone quake may differ from north to south. Quakes originating in the northern portion of the CSZ tend to rupture the full length of the subduction zone. In southern Oregon and Northern California, quakes along the subduction zone appear to strike more frequently.

Benioff (Deep) Zone

Deep intraplate earthquakes may have magnitudes up to 7.5, with probable recurrence intervals of about 50 to 100 years (recurrence intervals are poorly determined by current geologic data). This source of earthquake events is not analyzed by the DOGAMI report but is a potential source of earthquake damage.

Crustal Zone

Based on the historical seismicity in Western Oregon and on analogies to other geologically similar areas, small to moderate earthquakes up to M5 or M5.5 are possible almost anywhere in Western Oregon, including Linn County. Although the possibility of larger crustal earthquakes in the M6+ range cannot be ruled out, the probability of such events is likely to be very low.

Previous Studies

DOGAMI has been analyzing earthquake hazards for many years. Initial analyses, published in 1999, evaluated factors including population and property distribution in the hazard area, the frequency of earthquake events, landslide susceptibility, buildings, infrastructure, and disaster preparedness of the region.[6] This type of analysis generated rough estimates of the damages to the county due to an earthquake event in a specific location. The CSZ event direct losses in this analysis amounted to a loss ratio of 5%, while the 500-year model event direct losses amount to a loss ratio of 12%.[7]

In 2007, DOGAMI completed a rapid visual screening (RVS) of educational and emergency facilities in communities across Oregon, as directed by the Oregon Legislature in Senate Bill 2 (2005).[8] RVS is a technique used by FEMA, known as FEMA 154, to identify, inventory, and rank buildings that are potentially vulnerable to seismic events. DOGAMI ranked each building surveyed with a 'low,' 'moderate,' 'high,' or 'very high' potential for collapse in the event of an earthquake. It is important to note that these rankings represent a probability of collapse based on limited observed and analytical data and are therefore approximate rankings. At that time DOGAMI surveyed 89 buildings in Linn County, of which 18 buildings were identified as having a

[6] Y. Wang & J.L. Clark, Special Paper 29, Earthquake Damage in Oregon: Preliminary Estimates of Future Earthquake Losses. 1999. DOGAMI.
[7] *Ibid.* The loss ratio is determined as a percentage of the expected losses to the county's economic base.
[8] DOGAMI - Open-File Report O-07-02, Statewide seismic needs assessment: Implementation of Oregon 2005 Senate Bill 2 relating to public safety, earthquakes, and seismic rehabilitation of public buildings

'very high' potential for collapse and 20 buildings were identified with a 'high' potential for collapse.

In 2008, DOGAMI developed regional earthquake hazard information to assess potential damages and losses for various earthquake scenarios in the Mid-Willamette Valley[9]. Interpretive Map Series IMS-24 assesses earthquake damage in Yamhill, Marion, Polk, Benton, Linn, and Lane Counties, and the City of Albany, Oregon. This analysis identified the primary geologic hazards of these jurisdictions, developed countywide earthquake and landslide hazard maps for each county, and developed earthquake damage and loss estimates for each community based on two earthquake scenarios - a magnitude ~6.5 crustal fault earthquake and a magnitude 9.0 Cascadia Subduction Zone earthquake. HAZUS – MH was used by DOGAMI to estimate various earthquake scenarios and estimate associated damage and loss, further detailed in Appendix E.

According to the National Seismic Hazard Map (Frankel and others, 2000), 75% of earthquake risk for Linn County is due to a CSZ-related earthquake; in comparison, a crustal earthquake makes up 4% of the earthquake risk. The remaining risk is from an earthquake with focal mechanisms in the subducting slab of the CSZ. The effects from either earthquake scenario present a challenge for planners and emergency managers preparing for hazard impacts.

DOGAMI, in partnership with other state and federal agencies, has undertaken a rigorous program in Oregon to identify seismic hazards, including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides.

The Oregon Resilience Plan, published in 2013, addresses the risks of a Cascadia Subduction Zone event and the elements needed for recovery from that type of earthquake hazard for the entire state.[10]

Mitigation of many essential facilities for earthquakes has been accomplished throughout Oregon through the Seismic Rehabilitation Grant Program of Business Oregon.[11]

Location and Extent

There have been several significant recent earthquakes in Western Oregon; some of which have been located in Klamath and Lake Counties in southern Oregon. The 1993 Scotts Mills earthquake was the most recent earthquake near Linn County. It is also known as the "Spring Break Quake" because it occurred on March 25. With a moment magnitude of 5.6 and a maximum perceived intensity of VII (Very strong) on the Mercalli intensity scale, at the time it was the largest earthquake in the Pacific Northwest since the Elk Lake and Goat Rocks earthquakes of 1981.

The region that includes Linn County has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered off the coast. All

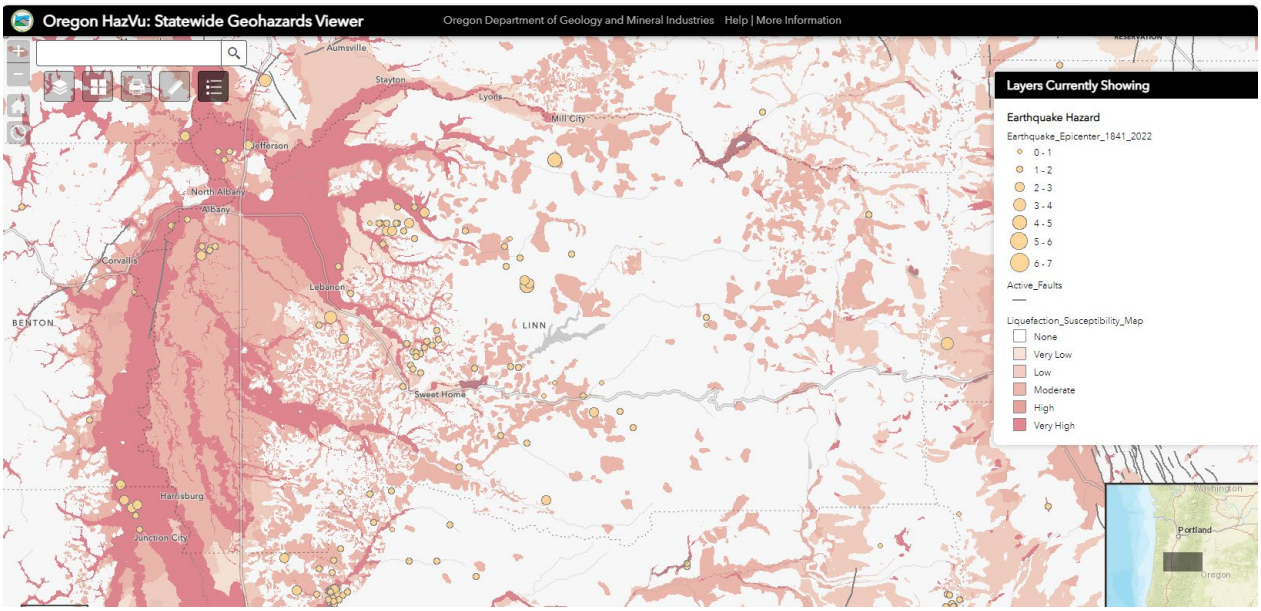
[9] Burns, William J., R. Jon Hofmeister, and Yumei Wang. Geologic Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage Estimates for Six Counties in the Mid/Southern Willamette Valley
[10] Oregon Seismic Safety Policy Advisory Commission, *Oregon Resilience Plan* (2013), https://www.oregon.gov/oem/documents/oregon_resilience_plan_final.pdf
[11] Business Oregon Seismic Rehabilitation Grant Program, https://www.oregon.gov/biz/programs/SRGP/Pages/default.aspx

considered, there is good reason to believe that future earthquakes will probably originate along shallow crustal faults in the region or along the offshore Cascadia Subduction Zone.

The severity of an earthquake is dependent upon several factors including: 1) the distance from the earthquake's source (or epicenter); 2) the ability of the soil and rock to conduct the earthquake's seismic energy; 3) the degree (i.e., angle) of slope materials; 4) the composition of slope materials; 5) the magnitude of the earthquake; and 6) the type of earthquake.

Figure 2-9, below, shows the susceptibility of soils in the region to become liquefied during an earthquake, epicenters of past earthquakes in and around Linn County, and active faults in the area. The Owl Creek Fault (southwest of Albany) and the Mill Creek Fault (north of Albany, just south of Salem) are the most significant for Linn County. The earthquakes shown in the figure below are relatively insignificant events below M2.0. The larger events may have been slightly felt but little to no structural or property damage resulted. Thus, the seismic hazard for Linn County arises predominantly from major earthquakes along the Cascadia Subduction Zone. Smaller, crustal earthquakes in or near Linn County could be locally damaging but would not be expected to produce widespread or major damage.

Figure 2-9. Earthquake Epicenters (1841-2022), Active Faults and Liquefaction Susceptibility



Source: Oregon HazVu: Statewide Geohazards Viewer

History

While Linn County has not experienced any significant earthquakes in recent history, earthquakes in Oregon that have affected the county are listed below[12]:

- **January 1700:** Offshore, Cascadia Subduction Zone (CSZ)- Approximate 9.0 magnitude earthquake generated a tsunami that struck Oregon, Washington, and Japan; destroyed

[12] Ivan Wong and Jacqueline D.J. Bolt, 1995, "A Look Back at Oregon's Earthquake History, 1841-1994", Oregon Geology, pp. 125-139; and Pacific Northwest Seismic Network, https://www.pnsn.org/earthquakes/notable..

Native American villages along the coast (additional CSZ events occurred approximately in 1400 BCE, 1050 BCE, 600 BCE, 400, 750, and 900)

- **November 1896:** McMinnville, 4.0 magnitude
- **July 1930:** Perrydale, 4.0 magnitude
- **April 1949:** Olympia, WA, 7.1 magnitude, significant damage in Washington, minor damage in NW Oregon
- **August 1961:** Albany, 4.5 magnitude, minor damage in Albany
- November 1962: Portland area, 5.5 magnitude, shaking lasted up to 30 seconds; chimneys cracked; windows broken; furniture moved
- **March 1963:** Salem, 4.6 magnitude, minor damage in Salem
- **November 1962:** Portland- A 5.2-5.5 magnitude earthquake caused damage to many homes (chimneys, windows, etc.); the earthquake was a crustal event
- **March 1993:** Scotts Mills- A 5.6 magnitude earthquake caused $27-$30 million in damage to homes, schools, businesses, state buildings (Salem). Crustal Event (FEMA-985-DR-OR)
- **September 1993:** Klamath Falls- Two earthquakes (5.9-6.0) caused two deaths and extensive damage. $7.5 million in damage to homes, commercial, and government buildings. Crustal event (FEMA-1004-DR-OR)
- **February 2001:** Nisqually, WA, 6.8 magnitude, felt in region, no local damage reported
- **October 2022:** ESE of Lacomb, OR, 4.4 magnitude earthquake. Eight other smaller quakes (less than 2.5 Mw) have occurred near Lacomb and near Cascadia since 2017.[13]

Probability Assessment

Linn County is susceptible to deep intraplate events within the Cascadia Subduction Zone (CSZ), where the Juan de Fuca Plate is diving beneath the North American Plate, and shallow crustal events within the North American Plate.

According to the Oregon NHMP, the return period for the largest of the CSZ earthquakes (M9.0+) is 530 years with the last CSZ event occurring more than 300 years ago in January of 1700. The probability of a 9.0+ CSZ event occurring in the next 50 years ranges from 7 - 12%. Notably, 10 - 20 “smaller” M8.3 - 8.5 earthquakes occurred over the past 10,000 years that primarily affected the southern half of Oregon and northern California. The average return period for these events is roughly 240 years. The combined probability of any CSZ earthquake occurring in the next 50 years is 37 - 43%.

Establishing a probability for crustal earthquakes is difficult given the small number of historic events in the region. Earthquakes generated by volcanic activity in Oregon’s Cascade Range are possible, but likewise unpredictable.

The NHMP Steering Committee assessed probability of future earthquakes based on their knowledge and experience in the county. Referencing available data, the NHMP Steering Committee determined that the **probability of experiencing a Cascadia Subduction Zone (CSZ) is “moderate”** with a score of 4.6 out of 10, meaning one incident is likely within 35-75 years. *The previous NHMP rated the earthquake probability as “high.”* The Steering Committee determined that **the probability of experiencing a crustal earthquake is also “moderate,”** with

[13] Latest Earthquakes (usgs.gov)

a score of 5.8 out of 10 meaning that they believe an incident may occur within the next 35 – 75-year period. *The previous NHMP rated a crustal earthquake probability as "moderate."*

Vulnerability and Impacts

Vulnerability to earthquake damage is related to the proximity of local faults, the county's proximity to the Cascadia Subduction Zone, potential slope instability in the foothills, and the prevalence of certain soils in the valley floor subject to liquefaction and amplification. The combination of these factors creates the county's risk profile for earthquake hazards. Based on the expected pattern of damage resulting from a CSZ event, the Oregon Resilience Plan divides the State into four distinct zones and places Linn County predominately within the "Willamette Valley Zone," from the summit of the Coast Range to the summit of the Cascades[14]. Within the Valley Zone damage and shaking is expected to be widespread but moderate, an event will be disruptive to daily life and commerce, and the main priority is expected to be restoring services to business and residents.[15] The impact of an earthquake emanating from a local fault has a different risk profile that considers the closer proximity of the fault line to Linn County critical facilities and community assets.

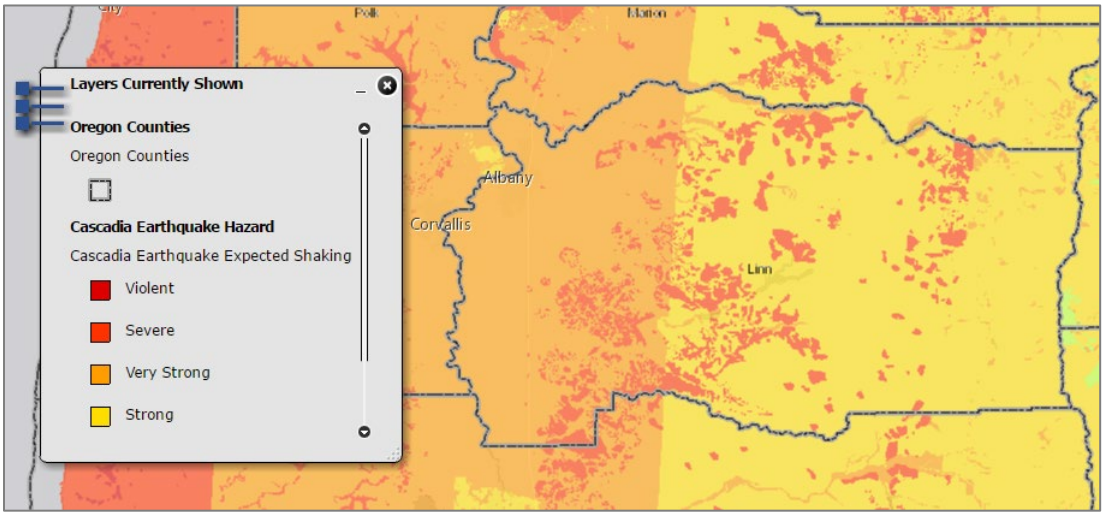
Overall, the environmental, economic, and social consequences of earthquake can be significant, including impacts to buildings, infrastructure, lifelines (e.g., utilities, communication systems, food distribution, healthcare access), natural and cultural resources, and short- and long-term impacts to the economy, including local, regional, and state-wide businesses, affecting people's jobs and access to goods and services, among others. Interstate and international trade could also be disrupted due to damage to Interstate 5, with broad economic ramifications. Related hazards, such as landslides and potential flooding from changes in watercourses and dam and levee failure, may also result from earthquakes. People may be displaced and in a worst-case scenario lives may be lost. Linn County may also be impacted by displaced coastal residents coming into the area due to tsunamis, further exacerbating housing need. Given current available data, it is beyond the capability of Linn County to assess these broader vulnerabilities and impacts at this time.

Cascadia Subduction Zone event

Figure 2-10 shows the expected shaking damage potential for Linn County due to a CSZ earthquake event. The figure shows that the county will experience "strong" to "severe shaking" that will last two to four minutes. The strong shaking will be extremely damaging to lifeline transportation routes including I-5, Highway 20, and Highway 99. For more information on expected losses due to a CSZ event see the Oregon Resilience Plan.

[14] Oregon Seismic Safety Policy Advisory Commission, *Oregon Resilience Plan* (2013), https://www.oregon.gov/oem/documents/oregon_resilience_plan_final.pdf
[15] Ibid.

Figure 2-10. Cascadia Subduction Zone Damage Potential

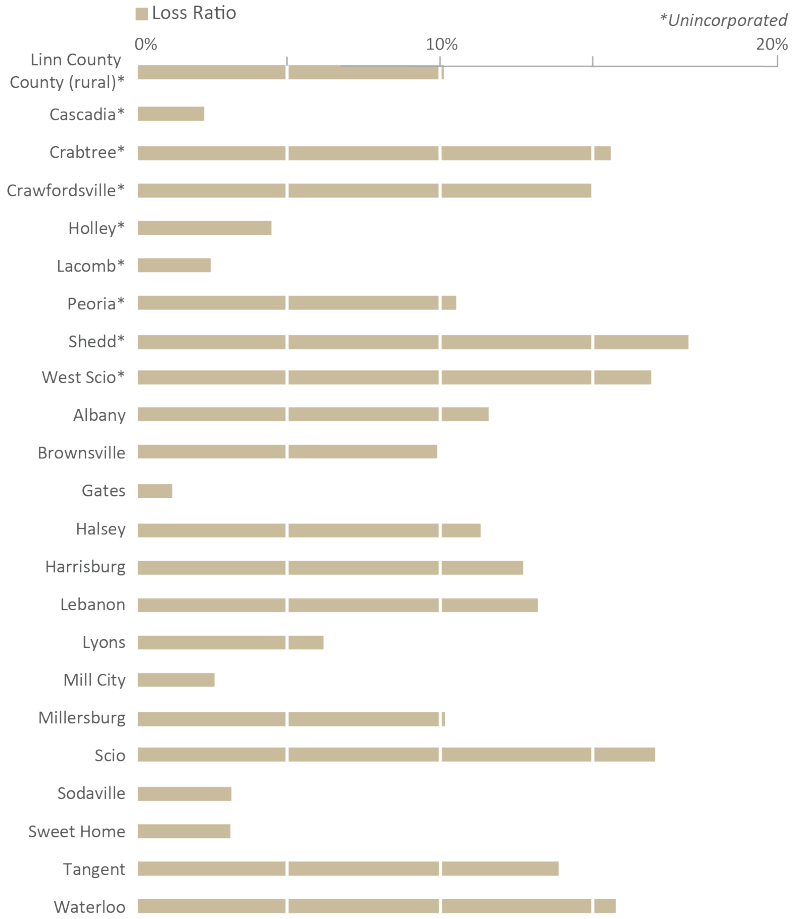


Source: Oregon HazVu: Statewide Geohazards Viewer, https://gis.dogami.oregon.gov/maps/hazvu/

The analysis for loss estimates from a CSZ event was based on the methodology described in the DOGAMI report, summarized here. Because an earthquake can affect a wide area, every building in Linn County will be shaken by a CSZ Mw-9.0 earthquake. Hazus-MH loss estimates for each building are based on a formula where coefficients are multiplied by each of the five damage state percentages (i.e., none, low, moderate, extensive, and complete). These damage states are correlated to loss ratios that are then multiplied by the total building replacement value to obtain a loss estimate (FEMA, 2022b). See Table B-2 in the DOGAMI report, included in Appendix E, for CSZ Mw-9.0 Earthquake loss estimates.

In keeping with earthquake damage reporting conventions, DOGAMI used the Applied Technology Council (ATC-20) post-earthquake building safety evaluation color-tagging system to represent damage states (Applied Technology Council, 2015). Red-tagged buildings correspond to a Hazus-MH damage state of "complete," which means the building is uninhabitable. Yellow-tagged buildings are in the "extensive" damage state, indicating limited habitability. Critical facilities were considered non-functioning if the Hazus-MH earthquake analysis showed that a building or complex of buildings had a greater than 50% chance of being at least moderately damaged (FEMA, 2022b). The number of potentially displaced residents from DOGAMI's CSZ earthquake scenario was based on the formula: ([Number of Occupants] * [Probability of Complete Damage]) + (0.9 * [Number of Occupants] * [Probability of Extensive Damage]) (FEMA, 2022b).

Figure 2-11. CSZ Mw 9.0 Earthquake Loss Ratio by Linn County Community



Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024.

The results indicate that Linn County could incur moderate to significant losses (10%) due to a CSZ Mw 9.0 earthquake. Most of the communities in Linn County can expect approximately 10% to 16% damage from a CSZ event. Much of the damage is due to soils that amplify seismic shaking.

Linn County CSZ Mw 9.0 earthquake results:
- Number of red-tagged buildings: 2,612
- Number of yellow-tagged buildings: 11,488
- Loss estimate: $2,637,395,000
- Loss ratio: 10%
- Non-functioning critical facilities: 35 of 154
- Potentially displaced population: 5,263

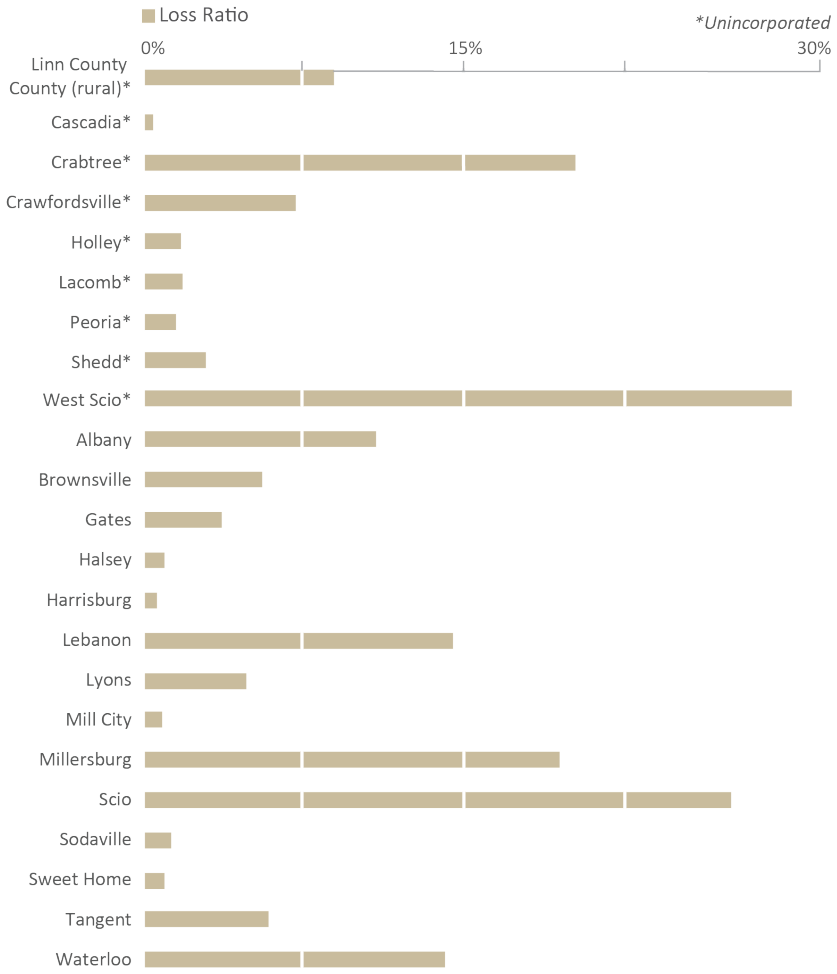
Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024.

Crustal Earthquake Event

The Turner and Mill Creek fault deterministic Mw 6.6 earthquake scenario was selected as the most appropriate for communicating the crustal earthquake risk for Linn County. While a CSZ event will cause substantial widespread damage throughout the entire study area, DOGAMI's

results indicate a Turner and Mill Creek fault Mw 6.6 earthquake will cause significant damage (15% - 30% in losses) to areas in the northwest portion of the county.

Figure 2-12. Earthquake Loss Ratio from Turner Mill Creek Fault Mw 6.6 by Linn County Community



Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024.

The results indicate that Linn County could incur losses near $2.4 billion or 8.8% of their total building assets from a Turner and Mill Creek fault Mw 6.6 earthquake. These results are strongly influenced by the proximity of buildings to the epicenter of the simulated earthquake. Communities in the northwestern portion of the county are not only close to the epicenter, but also are in areas of highly liquefiable soils. In addition to proximity, liquefaction would exacerbate the level of risk from this earthquake scenario for the communities in this part of the county. DOGAMI reviewed the results in ArcMap™ and observed residential buildings in Albany and commercial buildings in Millersburg in the area where Truax Creek flows into the Willamette River have a high risk of damage from this earthquake due to liquefaction hazard. Other areas that are at risk from this earthquake are along the South Santiam River which includes the communities of Crabtree and Lebanon. Communities along Thomas Creek, including the communities of Scio and West Scio, are at much greater risk from this earthquake than other communities in Linn County.

Linn County Turner and Mill Creek fault Mw 6.6 earthquake results:
- Number of red-tagged buildings: 2,749
- Number of yellow-tagged buildings: 8,942
- Loss estimate: $2,369,796,000
- Loss ratio: 8.8%
- Non-functioning critical facilities: 34 of 154
- Potentially displaced population: 5,286

Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024.

Using the OEM-FEMA Hazard Vulnerability Assessment methodology, the NHMP Steering Committee rated the county's vulnerability to earthquake damage using their knowledge and experience of this hazard. The Steering Committee rated Linn County as having a **"moderate" vulnerability to the Cascadia Subduction Zone (CSZ) earthquake hazard** with a score of 7.7 out of 10, meaning that between 1% and 10% of the region's population or assets would be affected by a CSZ earthquake, and a **"moderate" vulnerability to crustal earthquakes**, with a score of 7.7 out of 10 meaning that between 1% and 10% of the region's population or assets would be affected by a major crustal earthquake emergency or disaster.

The previous NHMP rated the CSZ earthquake vulnerability as "high" and vulnerability to a crustal earthquake event as "moderate." The assessment of the 2024 Steering Committee rated vulnerability "moderate" for both earthquake scenarios.

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley of the Oregon NHMP (2020) and future updates.

Flood

Significant Changes Since Previous Plan:

Additional flooding history was added. DOGAMI's Multi-Hazard Risk Report contributed estimates of loss using depth grids based on data from FEMA's Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for Linn County.

The Steering Committee's assessment of the Probability factor remained "high," and the ranking of the Vulnerability factor remained "moderate."

Characteristics

Flooding results when rain and snowmelt create water flow that exceeds the carrying capacity of rivers, streams, channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall. Many of Oregon's most destructive natural disasters have been floods.[16] The principal types of flooding that occur in Linn County include riverine floods, shallow area flooding, and urban flooding where stormwater conveyances are overwhelmed by flood waters.

[16] Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. 1999

Floods frequently occur in Linn County during periods of heavy rainfall. The DOGAMI report identifies the major rivers and creeks within the county as the Calapooia, North Santiam, South Santiam, and Willamette rivers and Ames, Cox, Crooks, Oak, Truax, and Thomas creeks. In addition, there are several tributaries to these major streams that have mapped flood zones. The prior Plan also identifies Crabtree Creek and Peter's Ditch as sources of flooding. All the mapped streams are subject to flooding and can cause damage to buildings in the floodplain.

Within the last 60 years there have been several major floods of note for Linn County; including floods that affected large areas and many communities. In December of 1964 heavy rainfall on snow occurred which caused major flooding on the Calapooia, North Santiam, Santiam, and Willamette rivers and Thomas and Ames creeks at historic levels. These floods caused damage to the communities of Albany, Jefferson, Scio, Sweet Home, and Cascadia. Due to flood regulation upstream of Linn County communities, such as flood storage areas along the Willamette River and the Detroit Dam, the flood damage that would have occurred was greatly reduced. Other notable floods occurred in 1966 and 1974 along Ames Creek which caused damage in the city of Sweet Home and surrounding areas (FEMA, 2016).

Location and Extent

Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies often use historical records, such as streamflow gages, to determine the probability of occurrence for floods of different magnitudes. The probability of occurrence is expressed in percentages as the chance of a flood of a specific extent occurring in any given year.

The magnitude of flood used as the standard for floodplain management in the United States is a flood having a probability of occurrence of one percent in any given year. This flood is also known as the 100-year flood or base flood. The most readily available source of information regarding the 100-year flood is the system of Flood Insurance Rate Maps (FIRMs) prepared by FEMA. These maps are used to support the National Flood Insurance Program (NFIP). The FIRMs show 100-year floodplain boundaries for identified flood hazards. These areas are also referred to as Special Flood Hazard Areas (SFHAs) and are the basis for floodplain management requirements.

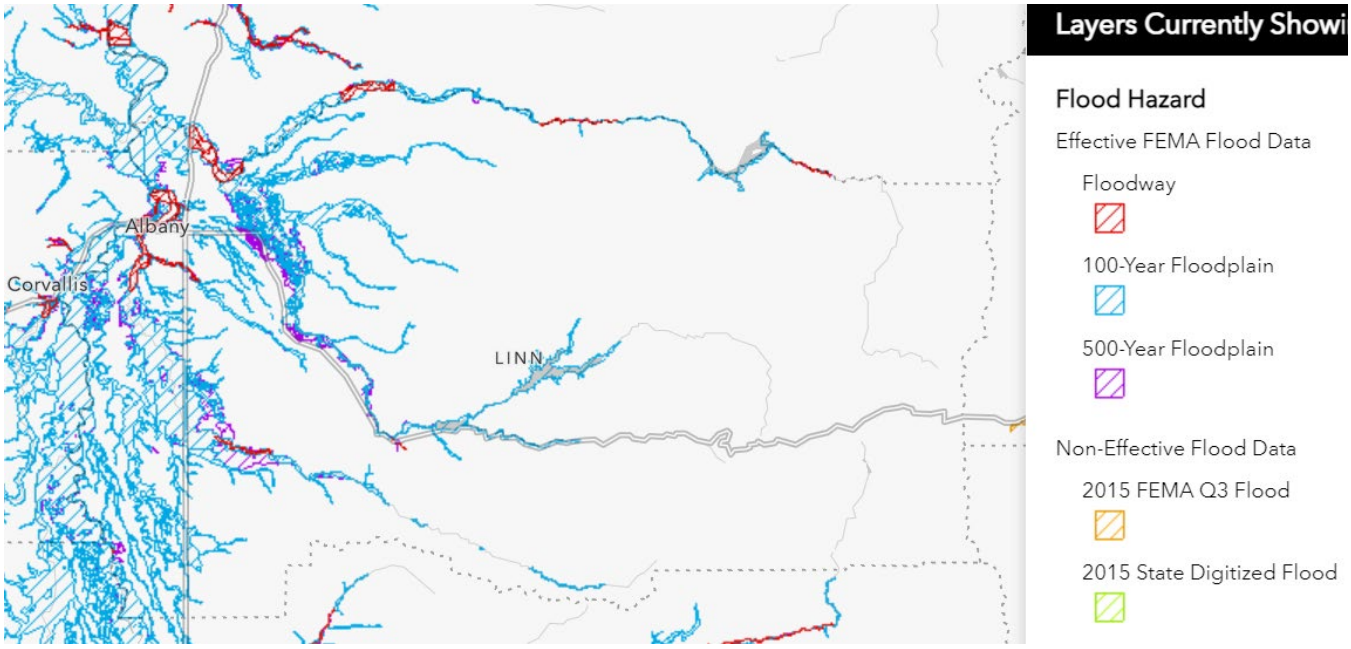
Most areas with significant development in Linn County do not fall within the mapped floodplains, however, Brownsville, Scio, and Tangent do have some areas that could be significantly impacted by flooding. In the past, commercial buildings in Albany, Lebanon, and Sweet Home have been impacted by flooding, however agricultural lands have suffered by far the most damage throughout the county. For more information, refer to the following Flood Insurance Study (FIS) and associated Flood Insurance Rate Maps (FIRM):

- Linn County Flood Insurance Study (Effective 12/08/2016)
- Marion County FIS that includes Gates (Effective 10/18/2019)

Additional information and reports are available at DOGAMI's Flood and Channel Migration webpage[17] and at the Oregon Department of Emergency Management's RiskMap webpage.[18]

[17] https://www.oregon.gov/dogami/flood/Pages/default.aspx
[18] https://www.oregon.gov/oem/emresources/plans_assessments/riskmap/pages/default.aspx

Figure 2-13. Location and Extent of Flood Hazard in Linn County



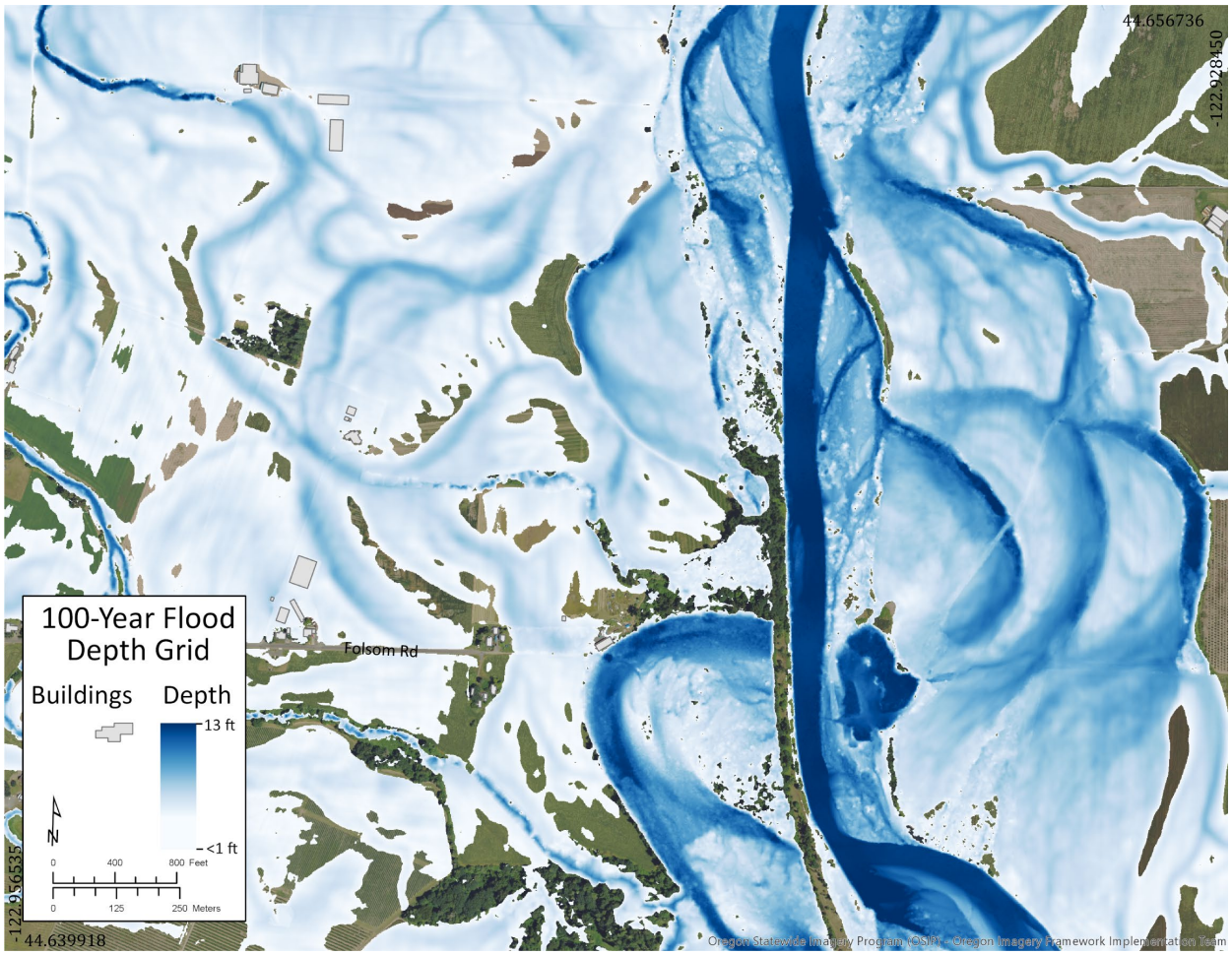
Source: Oregon HazVu: Statewide Geohazards Viewer, http://gis.dogami.oregon.gov/maps/hazvu

The DOGAMI analysis is based on high resolution lidar[19] to calculate flood depths using the FEMA FIS and the FIRMs. DOGAMI developed the 10-, 50-, 100-, and 500-year depth grids from detailed stream information and high-resolution lidar collected in 2009 and 2012.[20] The set of depth grids were used in this risk assessment to determine the level to which buildings are impacted by flooding.

Depth grids are raster Geographic Information System (GIS) datasets in which each digital pixel value represents the depth of flooding at that location within the flood zone, as shown in Figure 2-14. Depth grids for four riverine flooding scenarios (10-, 50-, 100-, and 500-year) were used for loss estimations and, for comparative purposes, exposure analysis.

[19] Lidar — Light Detection and Ranging — is a remote sensing method used to examine the surface of the Earth.
[20] Willamette Valley 2009 project and Central Coast 2012 project - Oregon Lidar Consortium; https://www.oregon.gov/dogami/lidar/pages/collectinglidar.aspx

Figure 2-14. Flood Depth Grid Example in Rural Linn County, Oregon



Note: The deepest depths (dark-blue) indicate the current position of the Willamette River.
Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024

History

Linn County has a lengthy flood history. The most serious flooding in Linn County occurs in December and January. These events are often associated with La Niña conditions that result in prolonged rain and rapid snowmelt on saturated or frozen ground. The resultant sudden impact of water swells rivers, causing tributary streams to overflow their banks and flood communities.

Annual intense rainfalls combined with snowpack in the Cascade Foothills, and the flat topography of the Willamette Basin, creates a setting for a history of floods in Linn County. Spring snowmelt sometimes causes problematic flooding. Water flows more quickly over logged forestland, transmitting more rainwater into streams and rivers more quickly. Sheet flooding that originates from agricultural land far from a source river or stream may not be predicted on federal FIRMs.

Listed below are historical flooding events in the mid-Willamette Valley region; little historical data is available for the remaining streams within the study area. Two significant flood events have been added since the previous plan (shown in *italics below*):

- **Dec. 1861:** Willamette Basin and Coastal Rivers - Preceded by two weeks of heavy rain. Every town on the Willamette was flooded or washed away. 635,000 cfs at Portland (greatest known flood on Willamette River, prior to the creation of a stream-gaging network for recording flood heights).
- **Feb. 1890:** Willamette Basin and Coastal Rivers - Second largest known flood in the Willamette Basin. Almost every large bridge washed downstream.
- **Dec. 1937:** Western Oregon - Flooding followed heavy rains. Considerable highway flooding; landslides.
- **Jan. 1953:** Western Oregon - Widespread flooding in western Oregon accompanied by windstorm.
- **Dec. 1964-Jan. 1965:** Willamette Basin - Highest recorded flooding throughout Willamette Basin. Two intense storms. Near-record early season snow depths. Largest flood in Oregon since dam construction on upper Willamette (1940s-50s); peak discharge of 320,000 cubic feet per second (cfs) was regulated to a peak of 186,000 cfs. Throughout the Willamette Valley, it caused $157 million in damage and 20 people lost their lives.
- **Jan. 1974:** Western Oregon - Flooding followed heavy wet snow and freezing rain. Nine counties received a Disaster Declaration. (FEMA-413-DR-OR)
- **Dec. 1978:** Western Oregon - Intense heavy rain, snowmelt, saturated ground.
- **Feb. 1986:** Entire State - Severe statewide flooding. Rain and melting snow. Numerous homes flooded and highways closed.
- **Feb. 1987:** Western Oregon - Willamette River and tributaries. Mudslides damaged highways and homes.
- **Feb. 1996:** Entire State - Deep snowpack, warm temperatures, record-breaking rains. Flooding, landslides, and power outages. (FEMA-1099-DR-OR)
- **Nov. – Dec. 1996:** Entire State - Record-breaking precipitation; local flooding and landslides. (FEMA-1149-DR-OR)
- **Dec. 2005 – Jan. 2006:** A very wet series of Pacific systems moved through northwest Oregon and southwest Washington dropping copious amounts of rainfall over the area. During the period, between 2-3 inches of precipitation fell over the Willamette Valley, and between 4-5 inches fell over parts of the Coast and Cascade Ranges. This period of heavy rainfall pushed many rivers above their banks, and most of those above flood stage. Many roads around the area were reported closed due to high water, and road workers were busy battling several landslides.
- **Jan. 2012:** Heavy rain, landslides, and downed trees. (FEMA-4055-DR-OR)
- **Dec. 2015:** Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides. (FEMA-4258-DR-OR*)*
- ***April 2019****: A particularly strong atmospheric river took aim for the south Willamette Valley, sitting over areas south of Salem for two days, producing from 2.5 to 5 inches of rain over a 48-hour period. Some areas in the Cascades and Cascade Foothills saw 5 to 7 inches of rain over that 48-hour period. Heavy rain combined with snowmelt from all the snow from a few weeks prior in this same area caused flooding along most of the rivers in this area as well as along the main-stem Willamette River up to around Oregon City.*

  The Willamette River near Harrisburg crested at 15.3 feet around 9 AM on April 9 (1.3 feet above flood stage) and at Albany the river crested at 27.3 feet around 10 PM on April 11 (2.3 feet above flood stage).

- ***Sept. 2020:*** *An eastward-moving upper-level trough and associated area of surface low pressure moved across northwest Oregon and southwest Washington September 17-18, resulting in widespread showers and thunderstorms beginning late in the afternoon of the 17th through most of the day on the 18th.*

  One severe thunderstorm developed southeast of Salem, OR during the overnight hours of September 17-18, and moved northward across the eastern Willamette Valley and Cascade Foothills before eventually weakening over northeast sections of the Portland metro area. This storm produced hail to near 1 inch in diameter, wind damage, and locally heavy rain with minor street flooding.

  A video of street flooding in Lebanon was posted on social media.

Probability Assessment

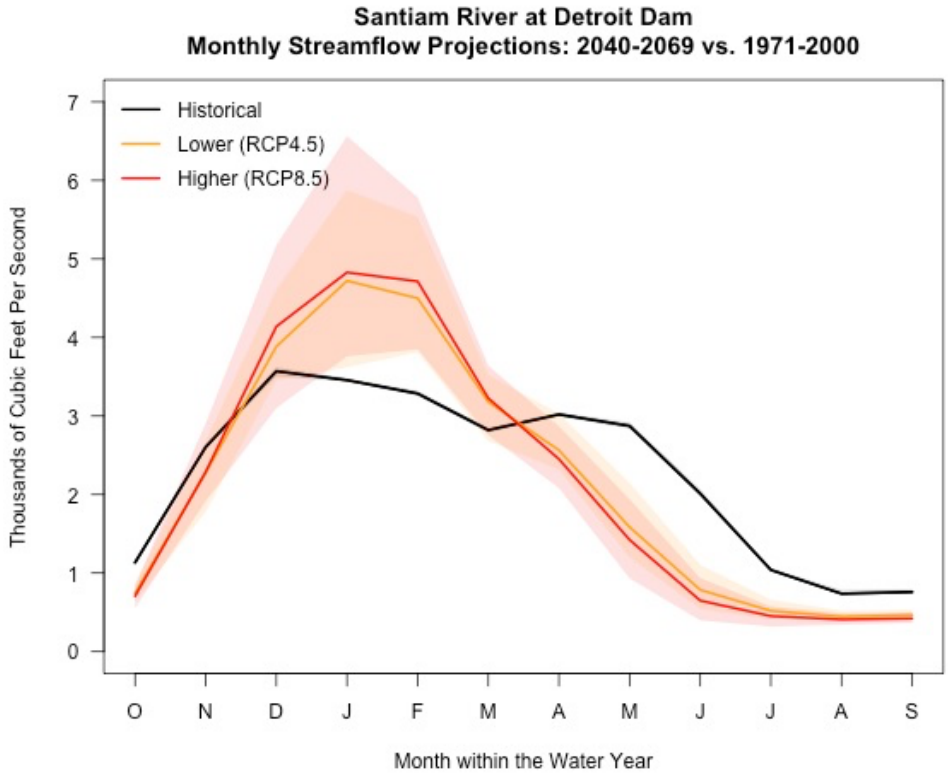
FEMA has mapped the 10-, 50-, 100-, and 500-year floodplains in portions of Linn County (see the above-mentioned FIRMs and FIS for more information). This corresponds to a 10%, 2%, 1%, and 0.2% chance of a certain magnitude flood in any given year. The 100-year flood is the benchmark upon which the NFIP is based.

Climate change has had a significant impact on flood hazards around the world, exacerbating the frequency, intensity, and magnitude of flooding events. The interplay between climate change and flood hazards is a complex phenomenon influenced by various factors such as rising temperatures, changing precipitation patterns, and altered hydrological cycles caused by warmer air holding more water vapor. These changes have a wide range of consequences for human populations, ecosystems, and infrastructure.

According to the OCCRI Future Climate Projections report, included as Appendix F, climate change will influence changes to flood hazard in Linn County. Predictive models indicate an increase in winter runoff levels and lower runoff during the summer and fall months. Winter flooding is projected to increase due to rain on snow occurrences as average winter temperatures increase. Warmer average temperatures, more extreme storms, including atmospheric rivers, and an increase in proportion of precipitation falling as rain instead of snow all will contribute to an increase of flood risk in Linn County.

The OCCRI report for Linn County reports that by the 2050s (2040–2069), under both emissions scenarios, the monthly hydrographs are projected to shift as the basins become rain-dominated. Winter streamflow is projected to increase due to increased winter precipitation, and the snowpack will melt earlier as temperatures increase and a greater percentage of precipitation falls as rain rather than snow. Figure 2-15 provides an example of the hydrographs used to make this assessment. Mean monthly flows do not translate directly to flood risk because floods occur over shorter periods of time. However, increases in monthly flow may imply increases in flood likelihood, particularly if increases are projected to occur during months in which flood occurrence historically has been high.

Figure 2-15. Hydrograph of Santiam River at Detroit Dam



Source: OCCRI Future Climate Projections, Linn County, Oregon, 2023

DOGAMI identified the following locations within the study area that are comparatively at greater risk of flood hazard:

- Many farms and residential structures south of Stayton (Marion County) are built within the floodplain of the Santiam River.
- Many buildings are at risk from flooding along Thomas Creek in the city of Scio.
- Flood risk is present in areas along the Willamette River, Mill Creek, and the South Santiam River.

Using the OEM Methodology and based on the background and experience of the Linn County Steering Committee members, the group determined the **probability of experiencing a flood is "high,"** meaning one incident is likely within the next 10 to 35-year period. *This rating has not changed since the previous plan*.

Vulnerability and Impacts

Overall, the environmental, economic, and social consequences of flooding can be significant, including impacts to buildings, infrastructure, lifelines, agriculture, the environment, cultural resources, and public safety, as well as short- and long-term impacts to the economy. Impacts to agriculture may affect food supply and lead to financial losses. Flooding that leads to streambank erosion can have lasting impacts on adjacent properties and infrastructure and deposition within waterways can affect water quality and quantity, impacting fish habitat and municipal water supplies, among other impacts. People may be displaced and in a worst-case

scenario lives may be lost. Given current available data, it is beyond the capability of Linn County to assess all of these broader vulnerabilities and impacts at this time.

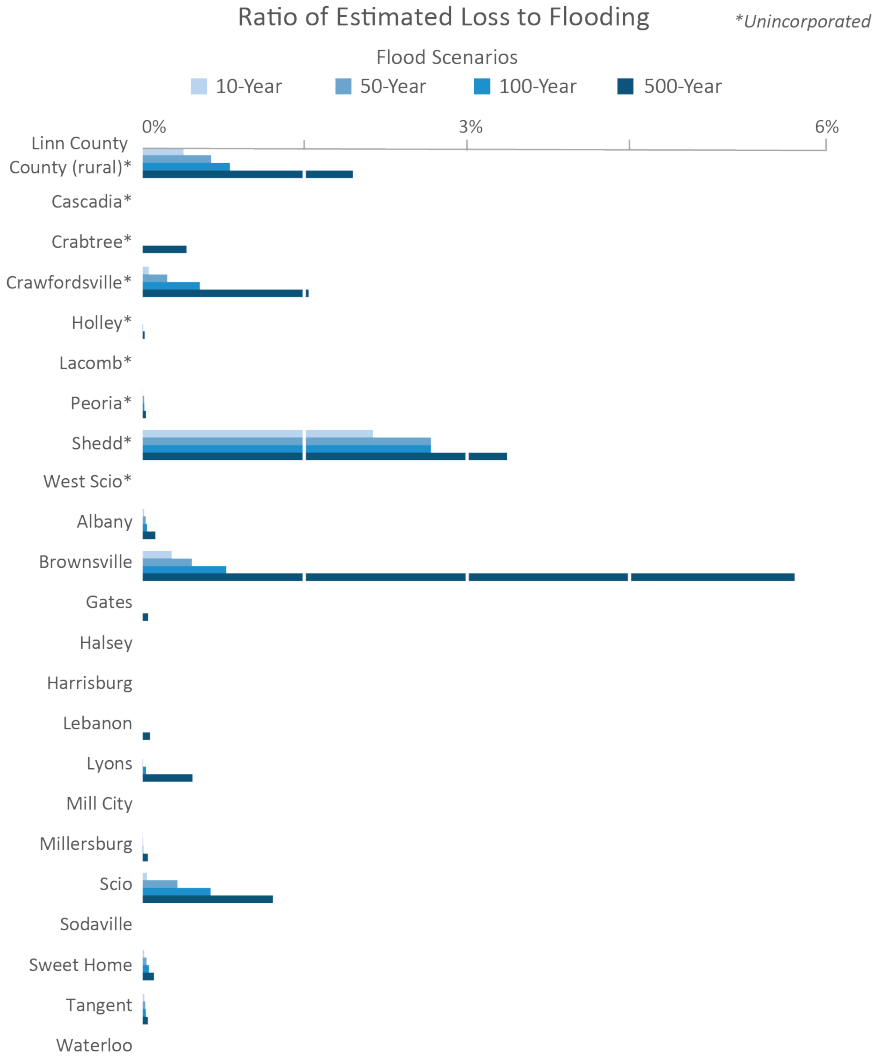
Dam safety is highly important when considering flood hazards. Dams are crucial structures designed to store and control water flow, but their failure, especially during periods of heavy rainfall and flooding, can lead to catastrophic consequences. Ensuring the safety of dams involves rigorous monitoring, regular inspections, and maintenance procedures. Structural integrity is a key concern, as any weaknesses or deficiencies in the dam's construction could be exacerbated by the force of floodwaters, potentially leading to a breach. Additional information regarding dam failure is discussed above and in Appendix E: DOGAMI Multi-Hazard Risk Report for Linn County.

Related to flooding, in places where development has occurred within a channel migration zone (CMZ), which is an area where dynamic processes have altered a stream's location over time, structures are at risk for severe damage to foundations and infrastructure through erosion and flooding. The CMZ typically extends beyond the limits of the regulatory floodplain. A significant number of buildings in the unincorporated county and cities along the Santiam and North Santiam rivers are within areas where channel migration is likely to occur. More information is available in Appendix E: DOGAMI Multi-Hazard Risk Report for Linn County.

The consequences of flooding may be determined by adverse effects to human activities within the natural and built environment, such as the destruction of homes and displacement from residences. These adverse conditions can be reduced through mitigation efforts, such as elevating structures above the expected level of flooding, removing structures through FEMA's property acquisition (buyout) program, or land use planning that considers risk from flooding. Changes to development patterns when additional structures are constructed in the floodplain have the potential to result in increased risk of flooding. County and city development regulations require adherence to floodplain management standards, but do not prohibit new development in areas identified as the 100-year floodplain. This reduces the impact of flooding on buildings, both existing and future, while also considering concerns about property rights.

DOGAMI used both HAZUS loss estimation software and depth grids derived from FEMA SFHA data to produce loss estimates that reflect local conditions as accurately as possible, further described in Appendix E.

Figure 2-16. Ratio of Flood Loss Estimates by Linn County Community



Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024

Building loss estimates are determined by DOGAMI using Hazus-MH by overlaying building data on a depth grid. Hazus-MH uses individual building information, specifically the first-floor height above ground and the presence of a basement, to calculate the loss ratio from a particular depth of flood.

For Linn County, occupancy type and basement presence attributes were available from the assessor database for most buildings. Where individual building information was not available from assessor data, DOGAMI analysts used street level imagery to estimate these important building attributes. Only buildings in a flood zone or within 500 feet of a flood zone were examined closely to attribute buildings with more accurate information for first floor height and basement presence. Because the analysis accounted for building first-floor height, buildings that have been elevated above the flood level were not given a loss estimate—but the analysis did count residents in those structures as displaced.

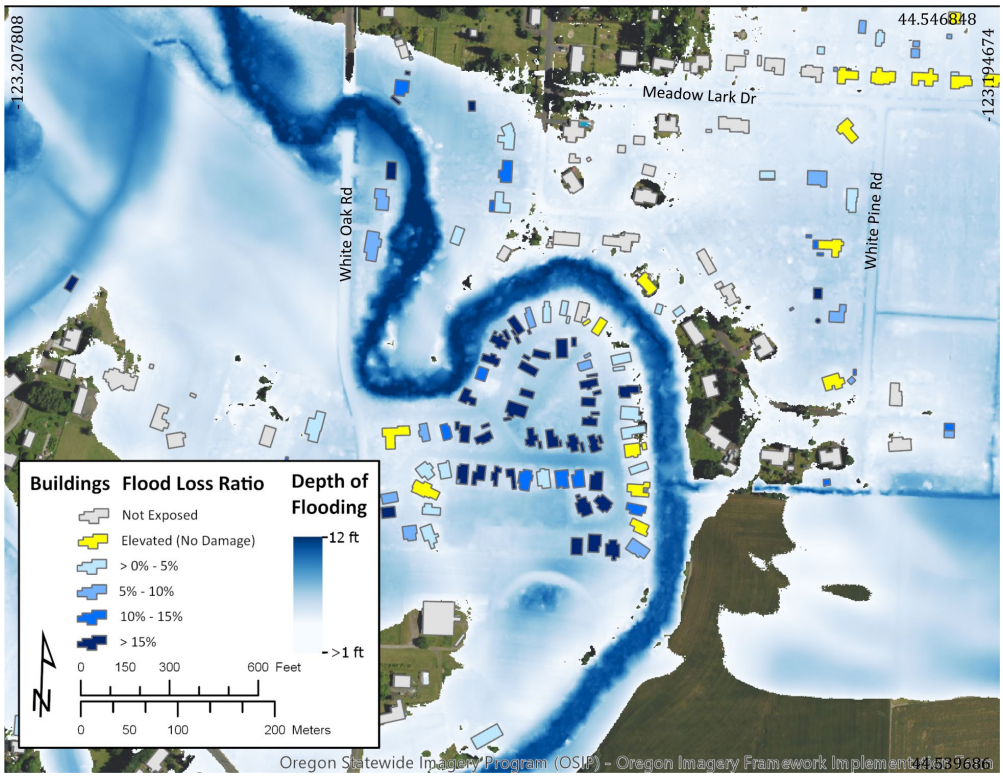
The Hazus-MH loss estimate for the 100-year flood scenario for the entire county is nearly $100 million. While the loss ratio of flood damage for the entirety of Linn County is 0.4%, the impact to areas of development near flood-prone streams is significant. In communities where most residents are not within flood designated zones, the loss ratio may not be as helpful as the actual replacement cost and number of residents displaced to assess the level of risk and impact from flooding. The Hazus-MH analysis also provides useful information for individual communities so that planners can identify problems and consider which mitigating activities will provide the greatest resilience to flooding.

Linn Countywide 100-year flood loss:
- Number of buildings damaged: 1,973
- Loss estimate: $99,287,000
- Loss ratio: 0.4%
- Damaged critical facilities: 3 of 154
- Potentially displaced population: 1,917

Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024.

Separate from the Hazus-MH flood analysis, DOGAMI did an exposure analysis by overlaying building locations on the 100-year flood extent. Analysts did this to estimate the number of buildings that are elevated above the level of flooding and the number of displaced residents. This was done by comparing the number of nondamaged buildings from Hazus-MH with the number of exposed buildings in the flood zone, as shown in the example in Figure 2-17, below.

Figure 2-17. 100-year Flood Zone and Building Loss Estimates Example in Rural Linn County



Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024

A small proportion (2.4%) of Linn County's buildings were found to be within designated flood zones. Of the 2,246 buildings that are exposed to flooding, DOGAMI estimated that 273 are above the height of the 100-year flood. This evaluation also estimates that 1,917 residents might have mobility or access issues due to being surrounded by rising floodwaters. Table 2-2, below, summarizes flood exposure for Linn County and its communities.

Table 2-2. Flood Exposure

Community	Total Number of Buildings	Total Population	1% (100-yr) Potentially Displaced Residents from Flood Exposure	1% (100-yr) % Potentially Displaced Residents from flood Exposure	1% (100-yr) Number of Flood Exposed Buildings	1% (100-yr) % of Flood Exposed Buildings	1% (100-yr) Number of Flood Exposed Buildings Without Damage
Unincorp. Linn Co	45,792	35,839	1,275	3.6%	1,735	3.8%	161
Cascadia	231	116	0	0%	0	0%	0
Crabtree	459	339	0	0%	0	0%	0
Crawfordsville	374	279	27	9.5%	35	9.4%	5
Holley	380	260	0	0%	1	0.3%	0
Lacomb	535	403	0	0%	0	0%	0
Peoria	136	97	0	0%	1	0.7%	0
Shedd	248	208	38	18%	44	18%	0
West Scio	198	105	0	0%	0	0%	0
Total Unincorp. County	48,351	37,644	1,340	3.6%	1,816	3.8%	166
Albany	20,286	48,668	108	0.2%	62	0.3%	4
Brownsville	1,326	1,846	180	9.7%	156	12%	37
Gates	326	493	0	0%	0	0%	0
Halsey	602	955	0	0%	0	0%	0
Harrisburg	1,924	3,660	0	0%	0	0%	0
Lebanon	8,789	20,320	0	0%	0	0%	0
Lyons	1,074	1,203	11	0.9%	8	0.7%	2
Mill City	1,060	1,671	0	0%	0	0%	0
Millersburg	2,049	3,207	9	0.3%	8	0.4%	3
Scio	601	949	210	22%	137	23%	50
Sodaville	271	357	0	0%	0	0%	0
Sweet Home	6,313	10,028	55	1%	46	1%	7
Tangent	1,064	1,218	4	0%	13	1%	4
Waterloo	203	216	0	0%	0	0%	0
Total	94,241	132,435	1,917	1%	2,246	2%	273

Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024

Overall, the main flooding problems within Linn County are primarily in the areas of Brownsville, Scio, Crawfordsville, and Shedd. The unincorporated county also has a high level of estimated damage from the major streams and their tributaries that flow through the county. There are few areas of concentrated flood damage in the study area. The small amount of damage that is estimated is scattered across the county at various places along the mapped streams.

Using the OEM Methodology the NHMP Steering Committee rated the county as having a **"moderate" vulnerability to flood hazards**, meaning that between 1% and 10% of the region's population or assets would be affected by a major flood event; *this rating has not changed since the previous plan.*

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley of the Oregon NHMP (2020) and future updates.

Landslide

Significant Changes Since Previous Plan:

Exposure analysis for landslides has been added to this section based on Hazus-MH analysis performed by DOGAMI, however, the level of detail available for mapping landslides in Linn County remains limited without updated lidar data.

The Steering Committee's assessment of the Probability of landslide remained "moderate," and the ranking of the Vulnerability factor also remained "moderate."

Characteristics

A landslide is any detached mass of soil, rock, or debris that falls, slides, or flows down a slope or a stream channel. Landslides are classified according to the type and rate of movement and the type of materials that are transported. In a landslide, two forces are at work: 1) the driving forces that cause the material to move down slope, and 2) the friction forces and strength of materials that act to retard the movement and stabilize the slope. When the driving forces exceed the resisting forces, a landslide occurs.

Linn County is subject to landslides or debris flows (mudslides), especially in the foothills of the Cascades, which may affect buildings, roads, and utilities. Additionally, landslides often occur together with other natural hazards, thereby exacerbating conditions, as described below:

- Shaking due to earthquakes can trigger events ranging from rockfalls and topples to massive slides.
- Intense or prolonged precipitation that causes flooding can also saturate slopes and cause failures leading to landslides.
- Landslides into a reservoir can indirectly compromise dam safety, and a landslide can even affect the dam itself.
- Wildfires can remove vegetation from hillsides, significantly increasing runoff and landslide potential.

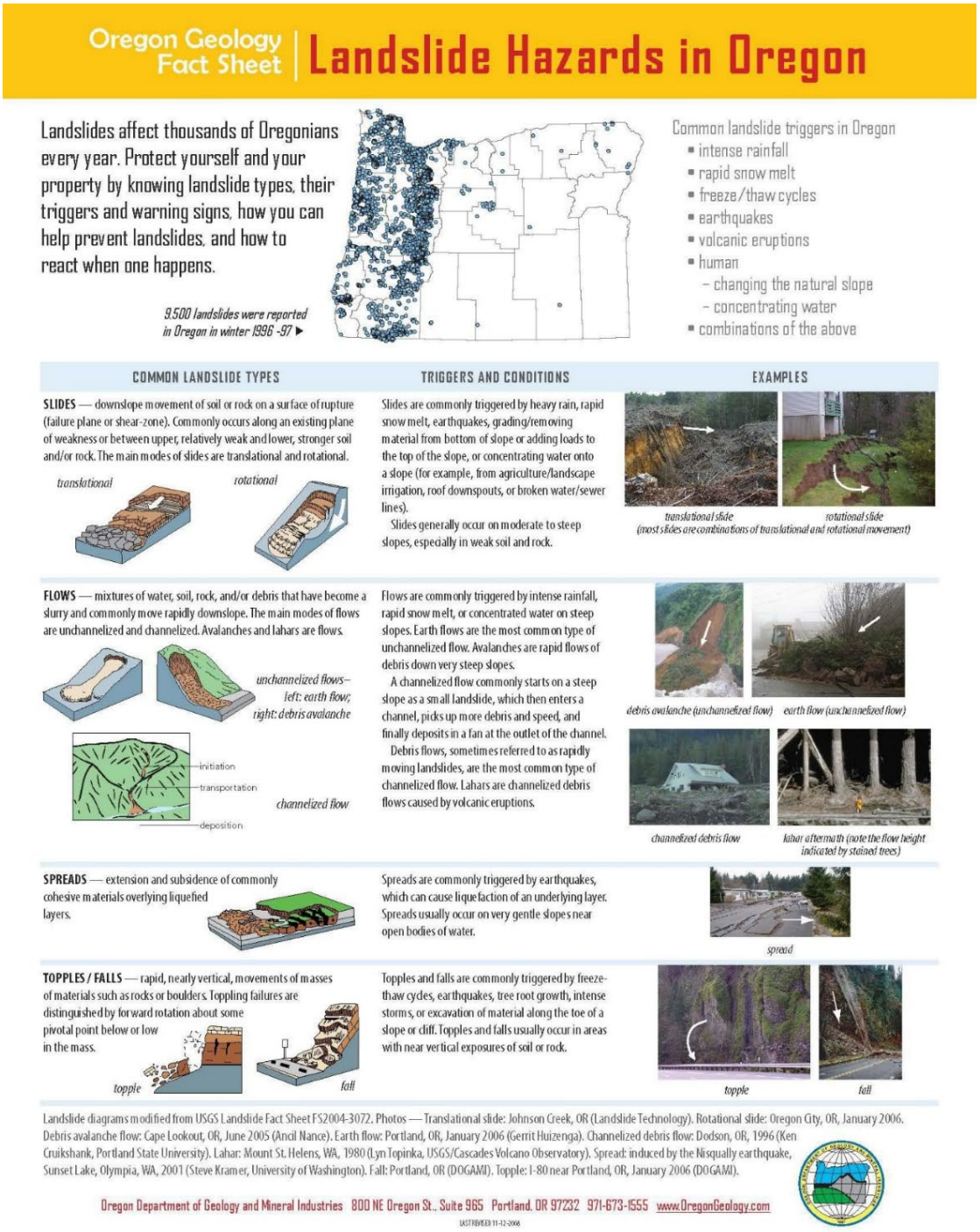
Types of Landslides

The general term “landslide” refers to a range of mass movement including rock falls, debris flows, earth slides, and other mass movements. All landslides have different frequencies of movements, triggering conditions, and very different resulting hazards.

All landslides can be classified into one the following six types of movements: (a) slides, (b) flows, (c) spreads, (c) topples, (d) falls, and (f) complex. Most slope failures are complex combinations of these distinct types, but the generalized groupings provide a useful means for framing discussion of the type of hazard associated with the landslide, the landslide characteristics, identification methods, and potential mitigation alternatives. These types of movements can be combined with other aspects of the landslide such as type of material, rate of movement, depth of failure, and water content for a better understanding of the type of landslide. Common types of landslides in Oregon are depicted in Figure 2-18, below.

One potentially life-threatening type of landslide is the channelized debris flow or “rapidly moving landslide,” which initiates upslope, moves into and down a steep channel (or drainage), and deposits material, usually at the mouth of the channel. Debris flows are also commonly initiated by other types of landslides that occur on slopes near a channel. They can also initiate within the channel in areas of accelerated erosion during heavy rainfall or snowmelt. Rapidly moving landslides have caused most of the recent landslide related injuries and deaths in Oregon. Debris flows or rapidly moving landslides caused eight deaths in Oregon in 1996 following La Niña storms.

Figure 2-18. Common Types of Landslides in Oregon



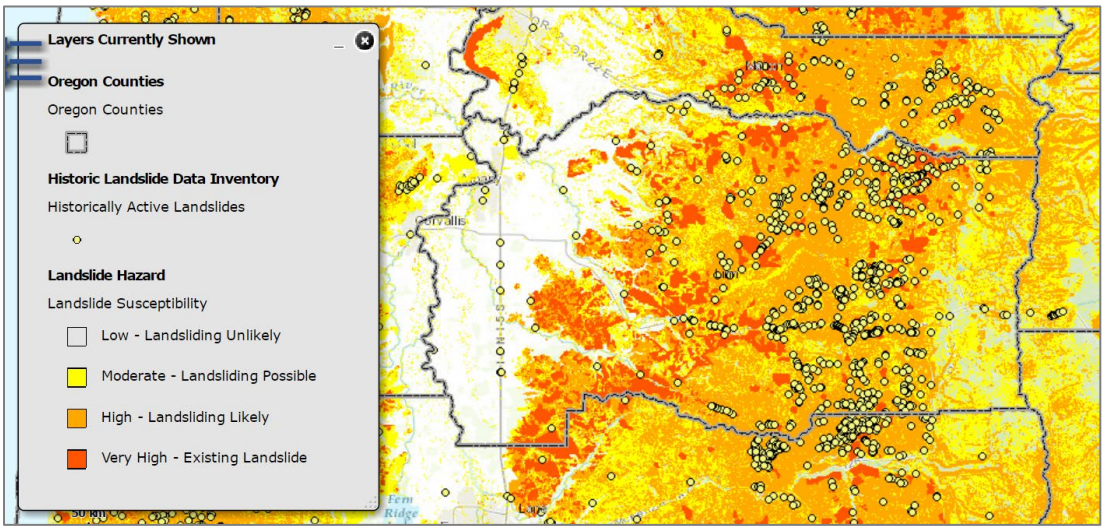
Source: DOGAMI, Landslides in Oregon fact sheet, https://pubs.oregon.gov/dogami/fs/landslide-factsheet.pdf

Location and Extent

The characteristics of the minerals and soils present in Linn County indicate the potential types of hazards that may occur. Rock hardness and soil characteristics can determine whether or not an area will be prone to geologic hazards such as landslides.

Landslides and debris flows are possible in any of the higher slope portions of Linn County, including much of the middle and eastern portions of the county, as shown in Figure 2-19. In north central Linn County, massive slope failures are present on the sides of Hungry Hill, Rogers Mountain, McCully Mountain, and other high ridges leading eastward towards Detroit Dam. The slides typically develop in the Little Butte Formation and undercut the crests, forming pronounced head scarps. Depth of failure is great below the larger head scarps, and landslide features are well-developed in places. Landslides are also occurring in the Cascades Formation on the lower flanks of Snow Peak. On the south side of the mountain along Crabtree Creek, rapid down cutting is initiating a series of active slides. Finally, numerous scattered patches of mass movement topography are mapped in the region bounded by Lebanon, Brownsville, and Sweet Home. Sliding is restricted to thick soils and tuffs of the Little Butte Formation. Most of these are underlain by basaltic intrusions and are generally stable. Figure 2-19 shows historic location of landslides as well as landslide susceptibility ratings for Linn County.

Figure 2-19. Historic Landslide Inventory and Landslide Susceptibility Rating



Source: DOGAMI Statewide Landslide Information Layer for Oregon, www.oregon.gov/dogami/slido/pages/index.aspx

More detailed landslide hazard assessment at specific locations requires a site-specific analysis of the slope, soil/rock, and groundwater characteristics at a specific site. Such assessments are often conducted prior to major development projects in areas with moderate to high landslide potential to evaluate the specific hazard at the development site.

For Linn County, many high landslide potential areas are in hilly-forested areas. Landslides in these areas may damage or destroy some timber and impact logging roads. Many of the major highways, with the exception of I-5, in Linn County are at risk for landslides at one or more locations with a high potential for road closures and damage to utility lines. Especially in the central and eastern portions of Linn County, with a limited redundancy of the road network, such road closures may isolate some communities.

In addition to direct damage to roads and highways, affected communities are also subject to the economic impacts of road closures due to landslides, which may disrupt access to/egress from communities. Table 2-3 shows landslide susceptibility exposure for Linn County and the incorporated cities. Approximately 50% of the county land has High or Very High landslide susceptibility exposure, while the cities generally have less exposure (except for Idanha). Note that even if a county or city has a high percentage of area in a High or Very High landslide exposure susceptibility zone, this does not mean there is a high risk, because risk is the intersection of hazard and assets.

Table 2-3. Landslide Susceptibility Exposure

Jurisdiction	Area, ft^2	Low	Moderate	High	Very High
Linn County	64,272,873,796	28.8%	21.4%	37.3%	12.5%
Albany	493,730,826	77.6%	20.5%	1.9%	0.0%
Brownsville	35,575,433	65.7%	13.8%	19.4%	1.1%
Halsey	15,747,777	98.1%	1.9%	0.0%	0.0%
Harrisburg	40,248,157	93.3%	5.3%	1.5%	0.0%
Idanha	23,496,523	29.9%	26.2%	21.0%	23.0%
Lebanon	189,742,294	85.5%	6.2%	5.5%	2.8%
Lyons	24,374,762	86.1%	11.6%	2.3%	0.0%
Mill City	23,105,987	74.5%	16.9%	8.6%	0.0%
Millersburg	126,183,608	80.8%	16.4%	2.9%	0.0%
Scio	11,469,571	92.9%	5.5%	1.7%	0.0%
Sodaville	8,456,767	25.2%	56.0%	9.0%	9.8%
Sweet Home	161,643,770	72.3%	17.1%	8.0%	2.6%
Tangent	104,961,049	96.2%	3.5%	30.0%	0.0%
Waterloo	3,424,384	88.9%	10.2%	0.8%	0.0%

Source: DOGAMI Open-File Report, O-16-02, Landslide Susceptibility Overview Map of Oregon (2016)

The severity or extent of landslides and debris flows is typically a function of geology and the landslide triggering mechanism. Debris flows can be initiated by heavy rainfall that carries soil, rocks, trees, and other debris rapidly in a channel to the debris flow fan on a gentler grade below where the most damage occurs. Rainfall initiated shallow landslides tend to be smaller, and earthquake induced deep landslides may be very large. Even small slides can cause property damage, result in injuries, or take lives.

For more information, refer to the DOGAMI Multi-Hazard Risk Report, 2024, provided as Appendix E. Additional reports are available on DOGAMI's Landslide webpage.[21]

History

Landslides may happen at any time of the year. In addition to landslides triggered by a combination of slope stability and water content, earthquakes may also trigger landslides. Areas prone to seismically triggered landslides are generally the same as those prone to ordinary (i.e.,

[21] https://www.oregon.gov/dogami/landslide/pages/landslidehome.aspx

non-seismic) landslides. As with ordinary landslides, seismically triggered landslides are more likely for earthquakes that occur when soils are saturated with water.

Debris flows and landslides are a very common occurrence in hilly areas of Oregon, including portions of Linn County. Many landslides occur in undeveloped areas and thus may go unnoticed or unreported. For example, DOGAMI conducted a statewide survey of landslides from four winter storms in 1996 and 1997 and found 9,582 documented landslides, with the actual number of landslides estimated to be many times the documented number. For the most part, landslides become a problem only when they impact developed areas and have the potential to damage buildings, roads, or utilities.

Below are listed the most severe landslide events; two landslide events have been added since the previous plan (as shown in *italics* below):

- **Feb. 1996:** Entire State - Deep snowpack, warm temperatures, record-breaking rains. Flooding, landslides, power outages. (FEMA-1099-DR-OR)
- **Nov. – Dec. 1996:** Entire State - Record-breaking precipitation; local flooding / landslides (FEMA-1107-DR-OR and FEMA-1149-DR-OR, *did not include Linn County*). The flood on the Willamette River in Salem was recorded as a 44-year flood event.
- ***Jan. 2012:*** *Severe winter storm, flooding, landslides, and mudslides (FEMA-4055-DR-OR).*
- ***Dec. 2015:*** *Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides (FEMA-4258-DR-OR)*

For additional history see the flood section above for events that included landslides.

Probability Assessment

The probability of landslides and rapidly moving landslides depends on a number of factors; these include steepness of slope, slope materials, local geology, vegetative cover, human activity, and water movement or rainfall intensity. There is a strong correlation between intensive winter rainstorms and the occurrence of rapidly moving landslides (debris flows). More data is needed to determine whether previously burned areas of forest are more prone to debris flows. This is a current area of research being conducted by DOGAMI and DLCD.

Many slower moving slides present in developed areas have been identified and mapped, however, the probability and timing of their movement is difficult to quantify. The installation of slope indicators or the use of more advanced measuring techniques could provide information on these slower moving slides.

DOGAMI used data from the Statewide Landslide Susceptibility Map (Burns and others, 2016), an analysis of multiple landslide datasets created using methods outlined in DOGAMI Special Paper Special Paper 42 (Burns and Madin, 2009), to analyze landslide susceptibility.

Burns and others (2016) used the Statewide Landslide Information Database for Oregon (SLIDO) along with maps of generalized geology and slope to create a landslide susceptibility overview map of Oregon that shows zones of relative susceptibility: Very High, High, Moderate, and Low.

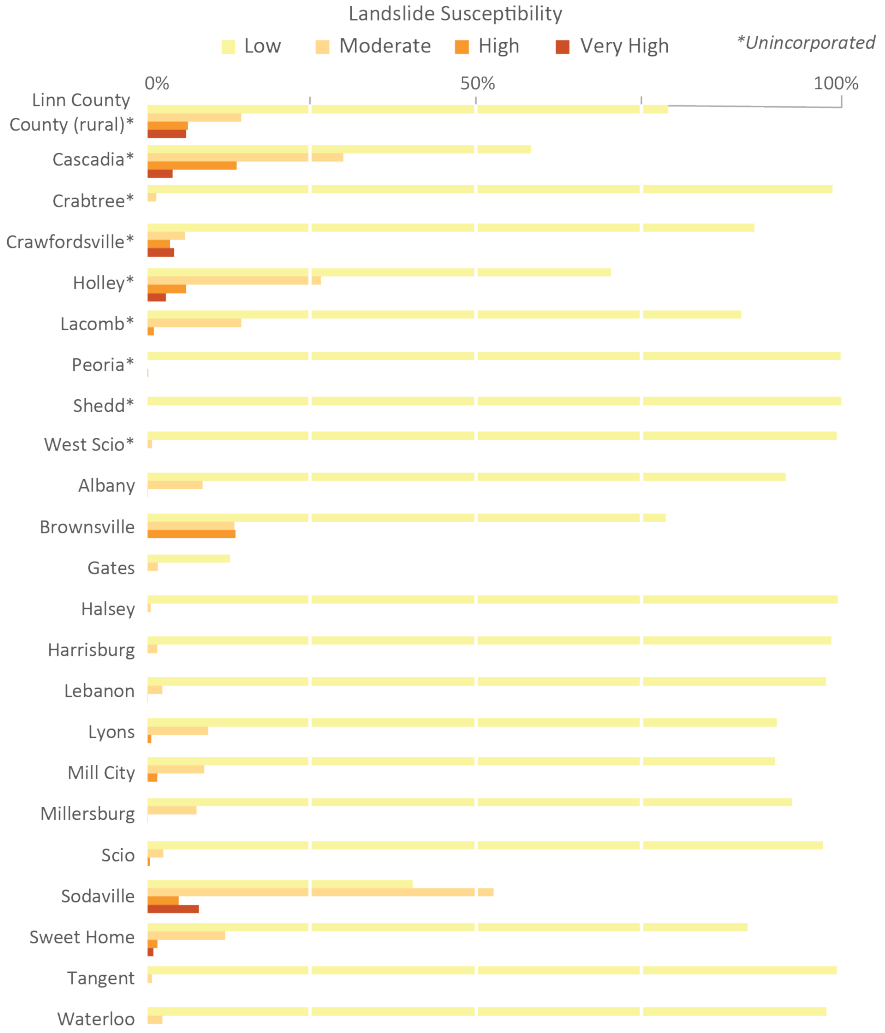
These data have the inherent limitations of SLIDO (i.e., differing levels of accuracy and resolution) and of the generalized geology and slope maps used to create the map. Therefore, the statewide landslide susceptibility map varies significantly in scale and application across the

state, depending on the details of the input datasets. Another limitation is that susceptibility mapping does not include some aspects of landslide hazard, such as runout, where the momentum of the landslide can carry debris beyond the zone deemed to be a high hazard area.

The landslide inventory in SLIDO for Linn County has not had any additional mapping since 2010 (in western half of Linn County) (McClaughry and others, 2010) and 2002 (in eastern half of Linn County) (Franczyk and others, 2021). This means the statewide landslide susceptibility layer in Linn County relies heavily on modeled slopes and generalized geology susceptibility to sliding, rather than detailed lidar-based landslide mapping. The scale of mapping in much of Linn County is considered the "least detail[ed]," meaning smaller than 1:62,500 map scale. Some of the county, the portion within the Willamette Valley, is more detailed, with scales between 1:8,000 to 1:62,500.

DOGAMI used data from Burns and others (2016) in the report to identify the general level of susceptibility of a given area to landslide hazards, primarily shallow and deep landslides. DOGAMI analysts overlaid building and critical facilities data on landslide susceptibility zones to assess the exposure for each community.

Figure 2-20. Landslide Susceptibility Exposure by Linn County Community



Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024

Climate change will influence landslide hazards in some landslide-prone areas where an increase in precipitation occurs. The frequency and magnitude of precipitation events can influence the probability of landslides occurring by saturating soils and prolonging the period in which soils remain saturated. Saturated soil increases landslide risk because soils are heavier, and the presence of water reduces friction in the potential landslide material. In addition, areas that have recently burned are far more likely to landslide after heavy rainfall. Since climate change is expected to increase the likelihood of wildfire, post wildfire debris flows are also at a higher chance of occurring. More information regarding future climate projections and landslides is available in Appendix F: OCCRI Future Climate Projections, Linn County, Oregon.

According to the OCCRI report, the annual number of days where soil saturation exceeds the threshold for landslide risk is expected to remain the same (31 days) as observed risk days from 2010-2022. The projection for landslide risk in Linn County is expected to not increase or decrease due to precipitation. However, precipitation is only one factor of several that influence landslide risk and this analysis does not account for all aspects of landslide hazard.

Using the OEM Methodology and based on the participants background and experience the members of the Linn County NHMP Steering Committee ranked the county as having **a "moderate" probability of Landslide** with a ranking of 6.4 out of 10. The probability of landslide varies widely, and susceptibility determination is a site-specific evaluation. *This rating has not changed since the previous plan*.

Vulnerability and Impacts

Landslides can affect utility services, transportation systems, and critical lifelines. Communities may suffer immediate damage and loss of service. Disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electric power, are essential to service community needs. Loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk of breakage from landslide movements as small as an inch or two.

Roads and bridges are subject to closure during landslide events. Because many Linn County residents are dependent on roads and bridges for travel to work, delays and detours are likely to have an economic impact on county residents and businesses. To evaluate landslide mitigation for roads, the community can assess the number of vehicle trips per day, detour time around a road closure, and road use for commercial traffic or emergency access.

Vulnerabilities in the county include major routes such as Highway 20, Highway 22, and Highway 126. DOGAMI analysts found that areas along Route 22 along the North Santiam River have a high level of exposure to landslide hazard.

Lifelines and critical facilities should remain accessible, if possible, during a natural hazard event. The impact of closed transportation routes may be increased if the closed road or bridge is a critical lifeline to hospitals or other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes is essential and should receive high priority.

Losses of power and phone service are also potential consequences of landslide events. Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas. Flood events can also

cause landslides, which can have serious impacts on gas lines. People may be displaced and in a worst-case scenario lives may be lost. Given current available data, it is beyond the capability of Linn County to assess all of these broader vulnerabilities and impacts at this time.

Generally, communities in the central and eastern portion of Linn County that have moderate to steep slopes or are at the base of steep hillsides may be exposed to landslides. The percentage of building value exposed to very high and high landslide susceptibility is approximately 5.5%, which equates to more than 6,700 buildings with a value approaching $1.5 billion.

Linn Countywide landslide exposure (High and Very High susceptibility):
- Number of buildings: 6,759
- Value of exposed buildings: $1,484,804,000
- Percentage of total county value exposed: 5.5%
- Critical facilities exposed: 2 of 154
- Potentially displaced population: 6,047

Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024

Most of the developed land in Linn County is located on the gentle terrain found in the Willamette Valley, which is predominantly classified as having a low landslide susceptibility. However, there are developed areas in the central part of Linn County where Highway 20 intersects Route 228, in the vicinity of Brownsville, Sodaville, Crawfordsville, and Holley, that are highly susceptible to landslide hazard. Landslide hazard is also ubiquitous in the eastern portion of Linn County which may present challenges for planning and mitigation efforts. Awareness of nearby areas of landslide hazard is beneficial to reducing risk for every community and rural area of Linn County.

DOGAMI identified locations within the study area that are comparatively at greater risk to landslide hazard:

- Nearly all of Linn County's exposure to landslide hazard occurs east of Brownsville and Lebanon.
- A very large number of buildings are exposed to very high landslide hazard between Lebanon and Sweet Home. Steep slopes are present in the South Santiam River valley.

Using the OEM Methodology and based on the NHMP Steering Committee members background and experience, members rated the county as having a **"moderate" vulnerability to landslide hazards** with a ranking of 3.8 out of 10, meaning that between 1% and 10% of the region's population or assets would be affected by a major disaster. *This rating has not changed since the previous plan.*

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley of the Oregon NHMP (2020) and future updates.

Smoke and Poor Air Quality

Significant Changes Since Previous Plan:

Smoke and Poor Air Quality was added to the 2025 Linn County MJ-NHMP to address this hazard occurrence separately from wildfire. It is not uncommon for smoke from distant fires to impact the county.

The Steering Committee's assessment of the Probability of Smoke and Poor Air Quality as "high" and the ranking of Vulnerability was also "high."

Characteristics

The hazard of Smoke and Poor Air Quality has been named for inclusion in several recent NHMP updates as communities recognize the impacts of smoke and resulting poor air quality from distant fires or air stagnation trapping particulates in smoke from wood stoves, prescribed fire, wildfire, field burning, and leaf burning.

Geographic Causes

The nature of air movement or stagnation in a valley causes inversion layers to form. At the valley floor daytime temperatures heat the air. In the evening, air further up the slope of the mountains cools faster than the air lower down the slope. Because cool air is slightly heavier than warm air, the cool air sinks into the valley which displaces the warm air above it to form a "lid". If the weather creates stagnant conditions this inversion "lid" may persist trapping air pollutant discharges to create poor air quality.

Air quality issues can occur widely across Linn County, affecting the unincorporated rural areas and the incorporated cities. There are many microclimates throughout the county which result in localized issues.

Sources of Pollutants

Wildfires tend to provide a wide-ranging source of smoke that can blanket large areas and be detrimental to the health of people, animals, and plants. Wood burning stoves tend to be a more concentrated, point source type of pollution that decreases air quality. Field burning is an agricultural technique that can contribute to air quality issues. Diesel emissions, often from vehicles on roads, also contribute to lower air quality.[22]

Regulatory Framework

The Clean Air Act of 1970 and the U.S. Environmental Protection Agency (EPA) established health-based National Ambient Air Quality Standards (NAAQS) for six air pollutants: carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and lead (Pb). The areas that fail to meet the standards are designated "non-attainment" and are required to develop plans to come into compliance with the standards. Once compliance with the standard is achieved, a maintenance plan is developed to ensure that

[22] Oregon Department of Environmental Quality, https://www.oregon.gov/deq/aq/programs/pages/diesel-health-effects.aspx

air quality will not be compromised in the future. Linn County is neither a nonattainment area nor a maintenance area.[23]

The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings. The Clean Air Act requires periodic review of the science upon which the standards are based and the standards themselves.

The Oregon Department of Environmental Quality (DEQ) is a regulatory agency with the responsibility to protect and enhance the quality of Oregon's environment. DEQ's "Air Quality Monitoring program is responsible for providing accurate scientific data concerning the State of Oregon's air quality to ensure that the state meets the National Ambient Air Quality Standards as required by the Federal Clean Air Act."[24]

Air Quality Pollutants

In its latest annual air quality report,[25] DEQ describes how air quality is impacted by wildfire smoke, as follows:

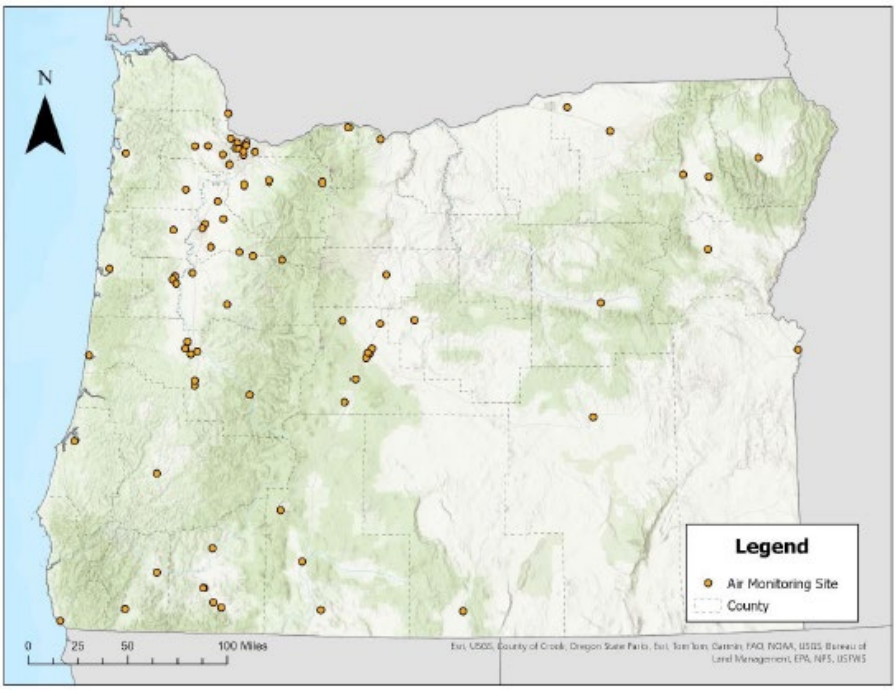
> "Oregon's ambient air quality was quite good in 2022 as communities experienced fewer days of poor air quality and less severe impacts compared to recent years. Smaller and fewer wildfires explain most of this improvement, as wildfire smoke is the primary cause of air quality degradation. Unlike recent years, the 2022 fire season lasted through October due to warm and dry weather conditions. As a result, the Cedar Creek fire burned well into the month and communities in and near the southern Willamette Valley experienced poor air quality. Oakridge experienced the most severe impacts due to its proximity to the fire. Communities in southern Oregon also experienced significant impacts from wildfires burning in northern California."

According to Oregon DEQ, for 2022 the air pollutants of primary concern in Oregon were $PM_{2.5}$, PM_{10}, and ozone as they degrade air quality most frequently.[26] To monitor these pollutants, DEQ and the Lane Regional Air Protection Agency (LRAPA) operate an ambient air quality monitoring network. Additional information regarding these pollutants of primary concern is provided below. Carbon dioxide, nitrogen dioxide and sulfur dioxide are pollutants of secondary concern in Oregon because they have had minimal impacts on air quality. DEQ monitors these pollutants in a few, select locations. All of these pollutants have trended downward, but $PM_{2.5}$ and ozone sometimes exceed national standards. [27]

Air quality monitoring network locations are shown in Figure 2-21, below. In Linn County, there are monitors in Albany, Sweet Home, Lebanon, and Scio. Tribal lands are sovereign and do not fall under DEQ's jurisdiction. Several of the tribes operate their own monitoring networks.

[23] Oregon Department of Environmental Quality, https://www.oregon.gov/deq/aq/pages/maintenance-areas.aspx
[24] DEQ, Air Quality webpage, accessed November 2024, https://www.oregon.gov/DEQ/aq/Pages/default.aspx
[25] DEQ, Oregon Air Quality Monitoring 2022 Annual Report, 2024, https://www.oregon.gov/deq/aq/Documents/AQMAnnualReport.pdf
[26] Ibid
[27] Ibid

Figure 2-21. Ambient Air Monitoring in Oregon in 2022



Source: DEQ, Oregon Air Quality Monitoring 2022 Annual Report, 2024, https://www.oregon.gov/deq/aq/Documents/AQMAnnualReport.pdf

Ozone

DEQ describes ozone as follows:

> "Ozone is a secondary pollutant formed when there are elevated levels of nitrogen dioxide (NO_2) and volatile organic compounds (VOCs) that undergo chemical reactions in high temperatures, and sunlight. In Oregon, elevated ozone occurs in the summer and can be formed by human-caused pollution from fossil fuel combustion and also by naturally caused pollution from wildfire smoke."[28]

Particulate Matter ($PM_{2.5}$ and PM_{10})

OCCRI's report states that with the increasing wildfires and $PM_{2.5}$ levels, there is a greater risk of wildfire smoke exposure through increasing frequency, length, and intensity of "smoke waves." "Smoke waves" are two or more consecutive days with high levels of $PM_{2.5}$ from wildfires.[29]

Fine particulate matter ($PM_{2.5}$) is a concern due to smoke impacts from woodstoves, fireplaces and other wood burning appliances besides wildfire smoke in the summer. Other sources of $PM_{2.5}$ include open burning, prescribed burning, wildfires, smoke from industrial stacks, and some road dust from vehicle travel. DEQ notes that it is useful to understand how much wildfire smoke can contribute to particulate levels above the NAAQS standard, because this shows the

[28] DEQ, Oregon Air Quality Annual Report: 2017.
[29] OCCRI, Future Climate Projections, Linn County, Oregon, 2023, included as Appendix F.

effectiveness of local air quality improvement in communities with particulate reduction plans to promote such actions as wood stove efficiency programs.

Identifying Poor Air Quality

The Air Quality Index (AQI) is a daily index of air quality that reports how clean the air is and provides information on potential health risks. Oregon's index is based on three pollutants regulated by the federal Clean Air Act: ground-level ozone, particle pollution, and nitrogen dioxide.[30] The AQI converts these and other ambient air pollutant concentrations into categories of health concern. The AQI uses index numbers, levels of health risk, and colors to communicate six categories of health concern and identifies air quality levels that range from good to hazardous, as shown in Table 2-4.[31]

Table 2-4. Air Quality Index Health Category Descriptions

Health Category	AQI	Description of Air Quality
Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk
Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Unhealthy	151 to 200	Members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Hazardous	301 & higher	Health warning of emergency conditions: everyone is more likely to be affected.

Source: DEQ, Oregon Air Quality Monitoring 2022 Annual Report, 2024

The AQI is computed for $PM_{2.5}$, PM_{10}, ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide but the PM2.5 and ozone AQI's are typically the highest in Oregon and usually drive the health category, as shown in Table 2-5, below.[32]

[30] DEQ Air Quality Today website, https://www.oregon.gov/deq/aq/pages/aqi.aspx
[31] DEQ, Oregon Air Quality Monitoring 2022 Annual Report, 2024, https://www.oregon.gov/deq/aq/Documents/AQMAnnualReport.pdf
[32] Ibid

Table 2-5. Air Quality Index Ranges and Episode Stages for PM2.5 and Ozone

Air Quality Rating	Air Quality Index (AQI)	$PM_{2.5}$ 24-hour Average ($\mu g/m^3$)	Ozone 8-hour Average (ppm)
GOOD	0 - 50	0.0 - 12.0	0.000 - 0.054
MODERATE	51 - 100	12.1 - 35.4	0.055 - 0.070
UNHEALTHY FOR SENSITIVE GROUPS	101 - 150	35.5 - 55.4	0.071 - 0.085
UNHEALTHY	151 - 200	55.5 - 150.4	0.086 - 0.105
VERY UNHEALTHY	201 - 300	150.5 - 250.4	0.106 - 0.200
HAZARDOUS	>300	>250.5	>0.200

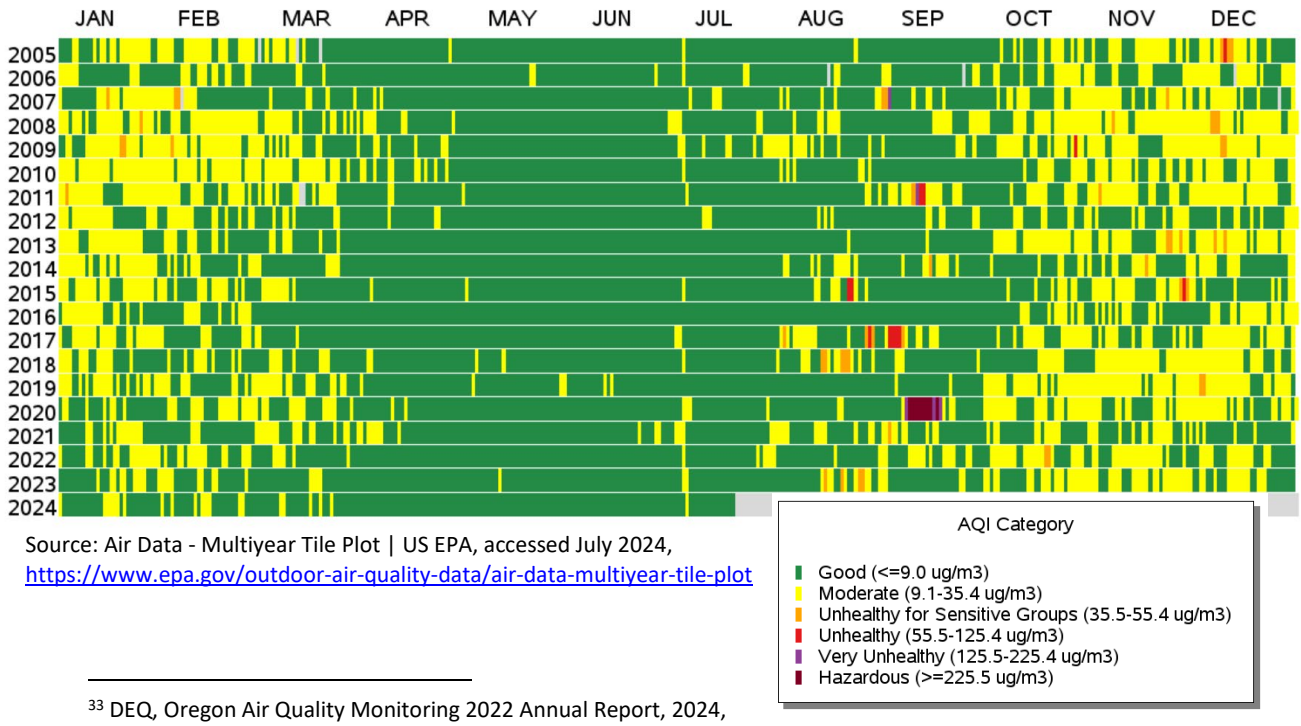
Source: DEQ, Oregon Air Quality Monitoring 2022 Annual Report, 2024

EPA provides all states with the AQI equation for national uniformity. The *Oregon Air Quality Annual Report* provides a review of the health levels over the past year, including a summary of AQI for each city in Oregon where DEQ and LRAPA monitor air quality.[33]

Location and Extent and History

Data is available to track poor air quality conditions in Linn County through four monitoring stations measuring $PM_{2.5}$. Figure 2-22, below, shows a pattern of periods of the year where the likelihood of high levels of particulate matter of 2.5 microns diameter has been present at that station.

Figure 2-22. PM2.5 Daily AQI Values, 2005 to 2024, Linn County, Oregon

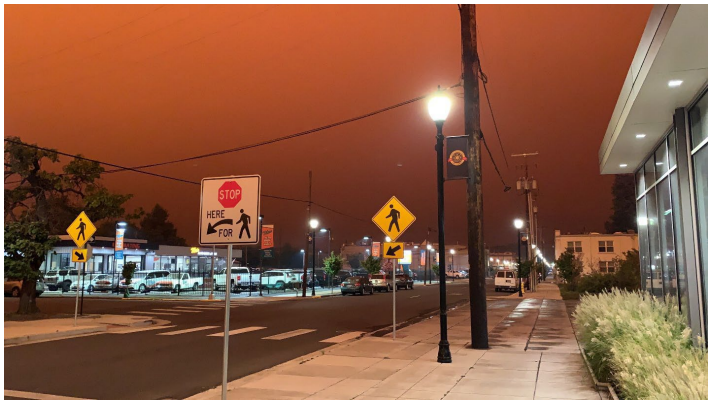


Source: Air Data - Multiyear Tile Plot | US EPA, accessed July 2024, https://www.epa.gov/outdoor-air-quality-data/air-data-multiyear-tile-plot

[33] DEQ, Oregon Air Quality Monitoring 2022 Annual Report, 2024, https://www.oregon.gov/deq/aq/Documents/AQMAnnualReport.pdf..

The county experienced extremely poor air quality during the September 2020 wildfires, as can be seen in the above chart. Below is a photo showing the impacts of poor air quality in Albany at 9 am on September 9, 2020.

Figure 2-23. City of Albany Poor Air Quality, September 9, 2020



Source: City of Albany staff

To provide up-to-date information to the general public, DEQ has updated its Air Quality Index, Air Quality Today (available online and as a mobile phone app), to put more data at users' fingertips. The color-coded tool categorizes air quality at more than 37 stations around Oregon. The updated Air Quality Index includes a number of new features:

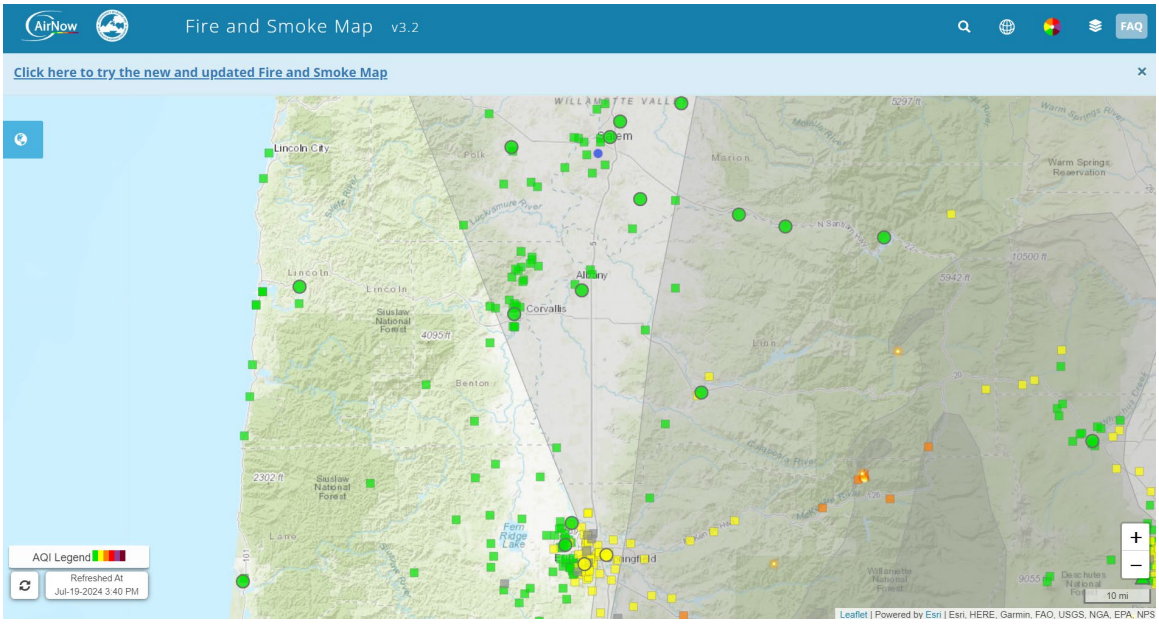
- Meteorological data
- Historical data that can be downloaded
- Tools to analyze data
- Information on air quality conditions in Lane County

Additionally, DEQ operates the Oregon Smoke Information website[34] with contributions from the Oregon Department of Forestry, OHA, the U.S. Forest Service, and the National Weather Service. This website provides advisories and information about air quality, smoke and health information, wildfire, extreme heat and smoke, multi-agency response protocol, and local and Tribal contacts, as well as how to sign up for local alerts.

The EPA maintains a real time Fire and Smoke monitoring map that provides useful information for NHMP plan holders to use. Below is an example of output from this real time mapping tool on July 19, 2024, for the Linn County area.

[34] https://www.oregonsmoke.org/

Figure 2-24. Fire and Smoke Map July 19, 2024, for the Linn County area



Source: Fire and Smoke Map (airnow.gov), https://fire.airnow.gov/?lat=44.9025&lng=-123.0518&zoom=10

Determination of the severity of the hazard of poor air quality and collecting data demonstrating the problem may provide support for mitigation actions aimed at managing prescribed burning to reduce the risk of high intensity wildfire and support for mitigation actions aimed at providing relief for vulnerable people during poor air quality conditions. The EPA Ambient Monitoring Technology Information Center provides information on monitoring programs and methods, quality assurance and control procedures, and federal regulations.[35]

Probability Assessment

OCCRI's analysis indicates that projected changes in climate may reduce outdoor air quality. Warmer temperatures may increase ground-level ozone concentrations, increases in the number and size of wildfires may increase concentrations of smoke and particulate matter, and increases in pollen abundance and the duration of pollen seasons may increase aeroallergens. Such poor air quality is expected to exacerbate allergy and asthma conditions and increase the incidence of respiratory and cardiovascular illnesses and death (Fann *et al.*, 2016). The OCCRI report notes that over the past several decades, the wildfire season has become longer. [36]

Using the OEM Methodology and based on the participants background and experience the members of the Linn County NHMP Steering Committee ranked the county as having **a "high" probability of Smoke and Poor Air Quality** with a ranking of 8.4 out of 10. The probability of Smoke & Poor Air Quality varies widely, and susceptibility determination is a site-specific evaluation.

[35] Ambient Monitoring Technology Information Center (AMTIC) | US EPA, https://www.epa.gov/amtic
[36] Future Climate Projections for Linn County, Oregon, OCCRI, 2023, included as Appendix F

Vulnerability and Impacts

Vulnerability to Smoke and Poor Air Quality is highest among the young, the elderly, and those with compromised health conditions. Those at high risk of adverse health outcomes as a result of wildfire smoke include people with preexisting conditions, outdoor workers, children, pregnant people, older adults, and rural and tribal communities (*York et al., 2020; Ho et al., 2021).*[37] Individuals with asthma or other limitations to lung capacity can be most at risk from this hazard. According to the Oregon Health Authority,[38] the particulate matter in wildfire smoke poses the biggest risk to the public's health. The potential health effects vary based on the type of plants burning, atmospheric conditions and, most importantly, the size of the particles. Particles larger than 10 micrometers(PM_{10}) usually irritate only the eyes, nose, and throat. Fine particles 2.5 micrometers or smaller ($PM_{2.5}$) can be inhaled into the deepest part of the lungs, and may cause greater health concern.

Smoke may worsen symptoms for people who have pre-existing health conditions and those who are particularly sensitive to air pollution. Sensitive groups include:

- Persons with asthma or other chronic respiratory disease
- Persons with cardiovascular disease
- Persons ≥ 65 years of age
- Infants and children
- Pregnant woman
- Smokers, especially those who have smoked for several years

Many residents of Linn County do not have air conditioning or air filters in their homes and several jurisdictions do not have spaces available to the public for use as clean air shelters. During prolonged exposure to smoke and poor air quality, people may need to leave the area if they do not have access to clean indoor air, however, people with fewer resources may not be able to leave their homes, potentially exacerbating health conditions.

Other impacts from smoke and poor air quality may include economic losses due to lost wages and productivity, particularly for outdoor workers, and lost revenue in areas that depend on outdoor recreation and tourism during the summer and early fall seasons, such as the Cascades area of eastern Linn County. Additionally, the cancellation of outdoor events and cultural activities due to smoke and poor air quality can affect community members' ability to gather and recreate and may result in economic losses to event organizers and vendors. Smoke can also impact certain crops, such as wine grapes and other table crops, which cannot be harvested due to smoke damage. Smoke or poor air quality can also lead to school closures and reduced learning time, along with after school outdoor activities, impacting children's education and development. Given current available data, it is beyond the capability of Linn County to assess all of these broader vulnerabilities and impacts at this time. The County has added a new multi-hazard action item to evaluate vulnerability of and impacts to community assets from smoke and poor air quality where feasible.

[37] Ibid.

[38] Oregon Health Authority Public Health Division, FAQ about wildfire smoke and public health, 10/17, https://sharedsystems.dhsoha.state.or.us/DHSForms/Served/le8626.pdf

Using the OEM Methodology and based on the participants background and experience, the Steering Committee members ranked the county as having **a "high" vulnerability to Smoke and Poor Air Quality** with a ranking of 8.1 out of 10.

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley of the Oregon NHMP (2020) and future updates.

Volcano

Significant Changes Since Previous Plan:

There were no significant changes to the Volcano Hazard section during this update.

The Steering Committee determined the Probability of experiencing volcanic activity is "low" and rated the county as having a "moderate" Vulnerability to volcanic activity. Both are unchanged from the prior NHMP.

Characteristics

The Pacific Northwest lies within the "ring of fire," an area of very active volcanic activity surrounding the Pacific Basin. Volcanic eruptions occur regularly along the ring of fire, in part because of the movement of the Earth's tectonic plates. The Earth's outermost shell, the lithosphere, is broken into a series of slabs known as tectonic plates. These plates are rigid, but they float on a hotter, softer layer in the Earth's mantle. As the plates move about on the layer beneath them, they spread apart, collide, or slide past each other. Volcanoes occur most frequently at the boundaries of these plates and volcanic eruptions occur when molten material, or magma, rises to the surface.

The primary threat to lives and property from active volcanoes is from violent eruptions that unleash tremendous blast forces, generate mud and debris flows, or produce flying debris and ash clouds. The immediate danger area in a volcanic eruption generally lies within a 20-mile radius of the blast site.

Location and Extent

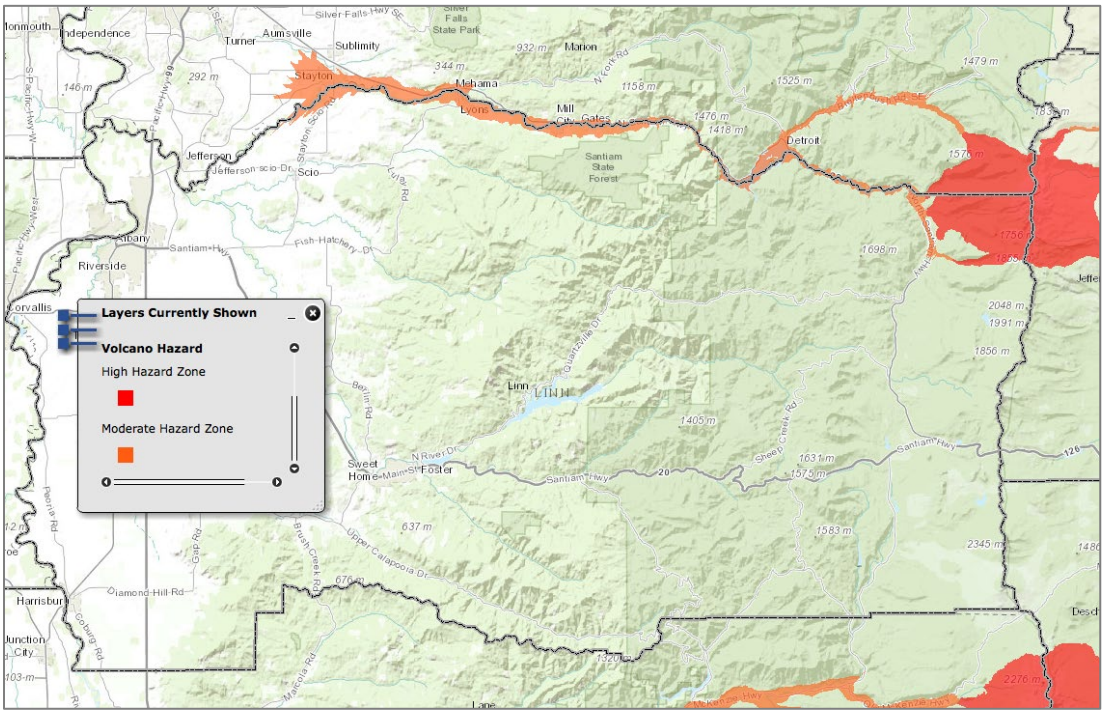
Linn County is located on the Pacific Rim. Tectonic movement within the earth's crust can renew nearby dormant volcanoes resulting in ash fallout. Volcanic activity is possible from Mount Hood, Mount St. Helens, Mount Jefferson, Three Sisters, Mount Bachelor, and the Newberry Crater areas. Because the distance to these potentially active volcanic areas is so great, the most likely adverse effect for most of the county is ash fallout, with perhaps some impact on water supplies. In general, the majority of the county's population and infrastructure will be minimally affected by volcanic activity. Additionally, the area potentially affected by ash fallout depends upon the height attained by the eruption column and the atmospheric conditions at the time of the eruption.

While volcanic eruption is not an immediate threat to the residents of Linn County, there is one active volcano within the county: Mount Jefferson. Nevertheless, the secondary threats caused by volcanoes in the Cascade region must be considered. Both Mount Jefferson and to the southeast the Three Sisters could send ash toward Linn County. Mount Jefferson could generate

lahar[39] flows that could affect the northern cities along the Linn County and Marion County border.

The north border of the county along the Santiam River is more at risk due to the possibility of lahar activity following the course of the river. Lahar flows from Mount Jefferson could impact Detroit, Mill City, Gates, Idanha, Mehama, Lyons and Stayton; see Figure 2-25.

Figure 2-25. Volcano Hazard Area



Source: Oregon HazVu: Statewide Geohazards Viewer, https://gis.dogami.oregon.gov/maps/hazvu/

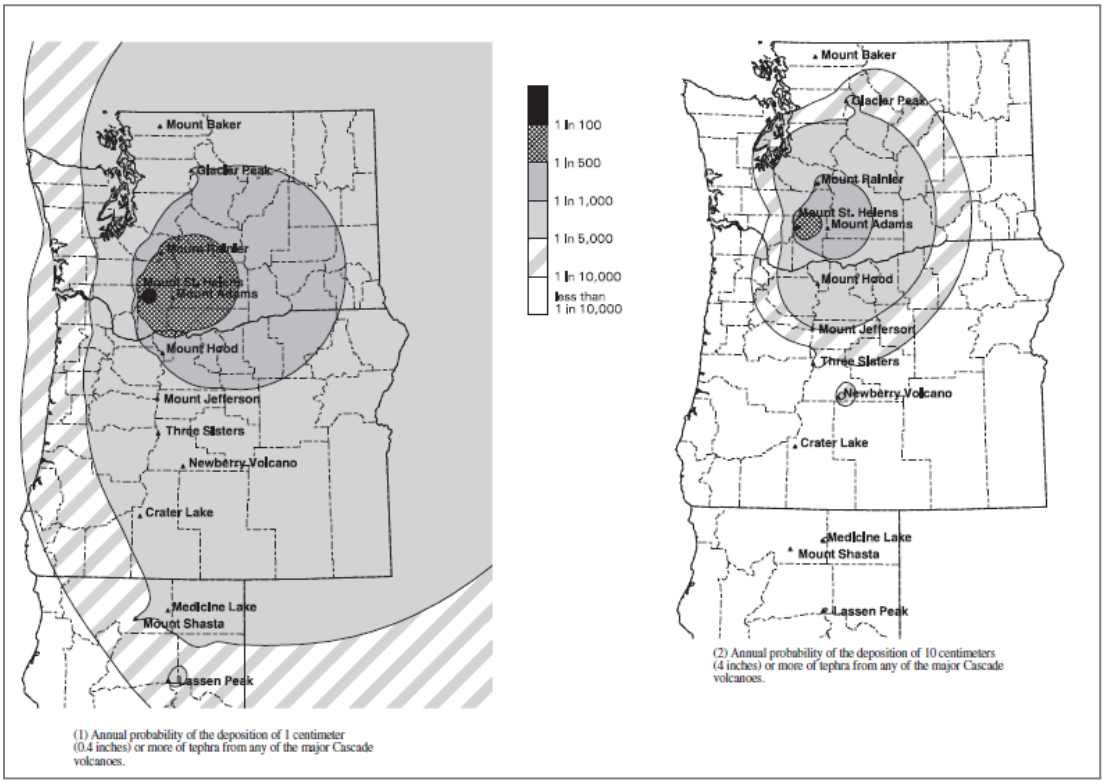
Geologic hazard maps have been created for most of the volcanoes in the Cascade Range by the U.S. Geological Survey (USGS) Volcano Program at the Cascade Volcano Observatory in Vancouver, WA, and are available at the Volcano Hazards Program's website.[40]

Scientists use wind direction to predict areas that might be affected by volcanic ash; during an eruption that emits ash, the ash fall deposition is controlled by the prevailing wind direction. The predominant wind pattern over the Cascades originates from the west, and previous eruptions seen in the geologic record have resulted in most ash fall drifting to the east of the volcanoes. Regional tephra fall shows the annual probability of ten centimeters or more of ash accumulation from Pacific Northwest volcanoes. Figure 2-26 depicts the potential and geographical extent of volcanic ash fall in excess of ten centimeters from a large eruption of Mount St. Helens.

[39] A lahar is a water-saturated mixture of muddy debris and rock fragments that originates from a volcano and flows down channels at a rapid speed (exceeding 120 mi/hr [200 km/hr])

[40] https://www.usgs.gov/natural-hazards/volcano-hazards/

Figure 2-26. Regional Tephra-fall Maps



Source: USGS "Volcano Hazards in the Mount Jefferson Region, Oregon"

History

Mount Hood and Mount St. Helens are two active volcanoes in the vicinity of Linn County. Mount Hood lies northeast of the county and is more than 500,000 years old. It has had two significant eruptive periods, one about 1,500 years ago and another about 200 years ago. Mount St. Helens is located in southern Washington and has been active throughout its 50,000-year lifetime. In the past 200 years, seven of the Cascade volcanoes have erupted, including (from north to south): Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens (Washington); Mount Hood (Oregon); Mount Shasta, and Mount Lassen (California). Mount Jefferson may have erupted about 1,100 years ago.

There has been no recent volcanic activity near the county. The 1980 explosion of Mount Saint Helens in southern Washington State is the latest on record; both Mount St. Helens, Mount Hood, and Mount Jefferson remain listed as active volcanoes.

Probability Assessment

The USGS-Cascades Volcano Observatory (CVO) produced volcanic hazard zonation reports for Mount St. Helens and Mount Hood in 1995 and 1997. The reports include a description of potential hazards that may occur to immediate communities. The CVO created an updated annual probability of tephra (ash) fall map for the Cascade region in 2001, which could be a rough guide for Linn County in forecasting potential tephra hazard problems. The map identifies the location and extent of the hazard.

The USGS volcanic tephra fall map on the previous page illustrates potential tephra fall in the region. It is based on the combined likelihood of tephra-producing eruptions occurring at Cascade volcanoes. Probability zones extend farther east of the range because winds blow from westerly directions most of the time. The map shows annual probabilities for a fall of one centimeter (about 0.4 inch). The patterns on the map show the dominating influence of Mount St. Helens as a tephra producer. Because small eruptions are more numerous than large eruptions, the probability of a thick tephra fall at a given locality is lower than that of a thin tephra fall. The annual probability of a fall of one centimeter or more of tephra is about 1 in 10,000 for Linn County. This is small when compared to other risks faced by the county.

Based on the available data and research for Linn County, the NHMP Steering Committee determined the **probability of experiencing volcanic activity is "low,"** meaning one incident is likely within the next 75 – 100-year period. *This ranking has not changed since the prior NHMP update.*

Vulnerability and Impacts

Risks for Linn County associated with regional volcanic activity would be ash fall, air quality, possible lahar flows within the Santiam River basin, and possible economic or social disruption due to air traffic issues due to the ash cloud.

Though unlikely, the impacts of a significant ash fall are substantial. Following an eruption, ash may take weeks to settle from the air. This fine powder is quite harmful to lungs and incredibly abrasive to moving parts of any machinery or engine. The weight of wet ash can collapse a building. People with respiratory problems are at risk. Transportation, communications, power, and other lifeline services may be interrupted. Surface water supplies may be contaminated, impacting water quality. Water intakes and drainage systems may become overloaded or clogged. Water and wastewater treatment facilities may also be impacted, leading to a reduction in capacity of these important services. Agriculture and the natural environment are also vulnerable and may be impacted by physical damage, soil alteration, and toxicity, making crops unsellable. Livability and the local, regional ,and state economy may be impacted by all of these direct effects. Any future eruption of a nearby volcano (e.g., Hood, St. Helens, or Adams) occurring during a period of easterly winds would likely have adverse consequences for the county. Given current available data, it is beyond the capability of Linn County to assess all of these broader vulnerabilities and impacts at this time.

Volcanic lahar flows and excess sediment and debris can cause significant economic, social, and environmental impacts to river valleys, floodplains, and adjacent development, including infrastructure and buildings. Longer-term, deposits can result in flooding for several years after an event. DOGAMI analyzed the exposure of people and buildings to a lahar flow coming from Mount Jefferson. The communities most threatened by volcanic eruption and lahar event are Gates, Lyons, and Mill City. Overall exposure is summarized as follows:

Linn County study area volcanic lahar exposure (Medium scenario):
- Number of buildings: 2,313
- Value of exposed buildings: $559,662,000
- Percentage of total county value exposed: 2.1%
- Critical facilities exposed: 6 of 154
- Potentially displaced population: 2,778

Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024

Based on the background and experience of the NHMP Steering Committee members, the committee rated the county as having a **"moderate" vulnerability to volcanic activity**, meaning that between 1% and 10% of the region's population or assets would be affected by a major disaster (volcanic ash). *This ranking has not changed since the prior NHMP update.*

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley of the Oregon NHMP (2020) and future updates.

Wildfire

Significant Changes Since Previous Plan:

The occurrence history for this hazard has been updated since the 2017 Linn County Plan. In addition, both the recently updated 2024 Community Wildfire Protection Plan and the DOGAMI Multi-hazard Risk Report findings were incorporated into this section.

The NHMP Steering Committee determined that the probability of experiencing a wildfire is "high," with a "moderate" vulnerability to wildfire hazards. Both of these ratings are unchanged since the previous plan.

Characteristics

Wildfires occur in areas with large amounts of flammable vegetation that require a suppression response under conditions of uncontrolled burning. Fire is an essential part of Oregon's ecosystem but can also pose a serious threat to life and property, particularly in the state's growing rural communities.

Wildfire can be divided into three categories: interface, wildland, and firestorms. The increase in residential development in interface areas has resulted in greater wildfire risk. Fire has historically been a natural wildland element and can sweep through vegetation that is adjacent to a combustible home. New residents in remote locations are often surprised to learn that moving away from built-up urban areas means they have also left behind readily available structural protection fire services.

The following three factors contribute significantly to wildfire behavior and can be used to identify wildfire hazard areas.

Topography: As slope increases, the rate of wildfire spread increases. South-facing slopes are also subject to more solar radiation, making them drier and thereby intensifying wildfire behavior. However, ridgetops may mark the end of wildfire spread, since fire spreads more slowly or may even be unable to spread downhill.

Fuel: The type and condition of vegetation plays a significant role in the occurrence and spread of wildfires. Certain types of plants are more susceptible to burning or will burn with greater intensity. Dense or overgrown vegetation increases the amount of combustible material available to fuel the fire (referred to as the "fuel load"). The ratio of living to dead plant matter is also important. The risk of fire increases significantly during periods of prolonged drought as the moisture content of both living and dead plant matter decreases. The fuel's continuity, both horizontally and vertically, is also an important factor.

Weather: The most variable factor affecting wildfire behavior is weather. Temperature, humidity, wind, and lightning can affect chances for ignition and spread of fire. Extreme weather, such as high temperatures and low humidity, can lead to extreme wildfire activity. By contrast, cooling and higher humidity often signals reduced wildfire occurrence and easier containment.

The frequency and severity of wildfires is also dependent upon other factors, such as lightning, drought, equipment use, railroads, recreation use, arson, and infestations. If not promptly controlled, wildfires may grow into an emergency or disaster. Even small fires can threaten lives and resources and destroy improved properties. In addition to affecting people, wildfires may severely affect livestock and pets. Such events may require emergency watering/feeding, evacuation, and shelter.

The indirect effects of wildfires can be catastrophic. In addition to stripping the land of vegetation and destroying forest resources, large, intense fires can harm the soil, waterways, and the land itself. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and enhance siltation of rivers and streams, thereby enhancing flood potential, harming aquatic life, and degrading water quality. Lands stripped of vegetation are also subject to increased debris flow hazards, as described above.

Location and Extent

Wildfire hazard areas are commonly identified in areas characterized as the Wildland Urban Interface or the WUI.

The WUI is the area where homes meet or intermingle with undeveloped wildland vegetation. This can be thought of as a transition zone between wildlands and human communities, and it makes the WUI a focal area for human-environment conflicts such as wildland fires. The word "urban" within the name can often be misleading, as the boundaries are generally inclusive of development in rural communities where fuels may be intermixed.[41]

The Linn County Community Wildfire Protection Plan (CWPP) was updated in 2024. The CWPP Steering Committee elected to use a WUI dataset provided by Oregon State University (OSU) in 2022, clipped to the boundaries of Linn County. For more information about the methods behind this dataset, see the CWPP's Appendix B: Risk Assessment Methods.

The Linn County WUI is approximately 114,314 acres, or 179 square miles, per the 2024 CWPP. Figure 2-29, below, shows the location of the WUI in Linn County. The overall WUI area is 109 square miles larger than the WUI defined in the 2007 CWPP. The increase in the WUI area can

[41] Linn County Community Wildfire Protection Plan, 2024, https://www.linncountyor.gov/planningbuilding/page/community-wildfire-protection-plan

be partially attributed to the difference in methodologies between the previous and current assessments. The present methodology includes more specificity involving different kinds of WUI areas, intermix, interface, and occluded, which allows a wider identification of communities that may be at risk. But generally speaking, the size of the WUI is the result of a pattern of dispersed residential development throughout areas of abundant vegetative fuels. New construction in Linn County since 2007 has also contributed to an increase of area within the WUI. According to Linn County Address Records, at least 4,604 new structures for habitation have been built since 2007 in the County with 3,896 of those now being identified within the WUI.[42]

The interface is the urban-rural fringe where homes and other structures are built into a densely forested or natural landscape. If left unchecked, it is likely that fires in these areas will threaten lives and property. One challenge Linn County faces is from the increasing number of houses being built in the urban/rural fringe as compared to twenty years ago. The "interface" between urban or suburban areas and the resource lands has significantly increased the threat to life and property from fires. Responding to fires in the expanding WUI area may tax existing fire protection systems beyond original design or current capability.[43]

The vast majority of Linn County's WUI, approximately 152 square miles, is defined as intermix. Generally, *intermix areas* are characterized by lower density developments that are scattered in a wildland area, where fuels are dispersed throughout. It is notable that several cities in Linn County are where the majority of area is classified as intermix WUI, including Lyons, Mill City, Sodaville, Waterloo, Brownsville, and Sweet Home. The high prevalence of intermix communities in Linn County means more residents are exposed to potential fire events in areas where there are not clear lines of demarcation between human development and wildlands.[44]

Figure 2-28. Example of an Intermix Community, Located in the Washburn Heights Subdivision near Brownsville, 2022

Source: Linn County CWPP, 2024

Figure 2-27. Example of an Interface Community Located in Sweet Home, 2022

Source: Linn County CWPP, 2024

[42] Ibid.
[43] Ibid.
[44] Ibid.

Smaller portions of the WUI are defined as interface or occluded, 20 square miles and seven square miles respectively. *Interface areas* tend to have more distinctly separate areas of human development and wildland fuels, though they often run adjacent to each other. *Occluded areas* are similarly distinct but are further removed from the wildland fuels - often not directly bordering fuel dense areas but within close proximity. Notable interface areas include the urban cores of Lebanon and Sweet Home, the city of Scio north of Thomas Creek, and communities at the southeast edge of Albany's urban growth boundary including Grande Prairie Subdivision and the Mennonite Village. Notable occluded areas include the city of Halsey and residential areas on the periphery of Millersburg and Lebanon.

The distribution of WUI areas across local fire protection districts shows that Lebanon, Sweet Home, and Scio Fire Districts have the largest amount of WUI by area. Close to 49,000 acres of WUI area is covered by the ODF's wildland fire protection boundaries, summarized in Table 2-6.

Table 2-6. Distribution of WUI Area by Fire Protection District

Fire District	WUI Area (Acres)	WUI Area (%)	Total Area (Acres)
Albany*	7,065	19%	36,908
Brownsville	6,491	15%	44,889
Corvallis	898	19%	4,763
Gates	1,468	37%	4,019
Halsey Shedd	2,523	4%	67,883
Harrisburg	1,600	3%	55,292
Idanha	156	12%	1,327
Jefferson	3,847	16%	23,536
Lebanon	**35,769**	42%	85,946
Lyons	5,246	31%	16,934
Mill City	1,039	87%	1,188
Mohawk	13	75%	18
Scio	**16,853**	26%	64,622
Stayton	4,292	26%	16,384
Sweet Home	**22,677**	23%	98,743
Tangent	1,234	4%	28,667
ODF North Cascade**	10,364	4%	289,500
ODF South Cascade**	38,533	5%	803,359

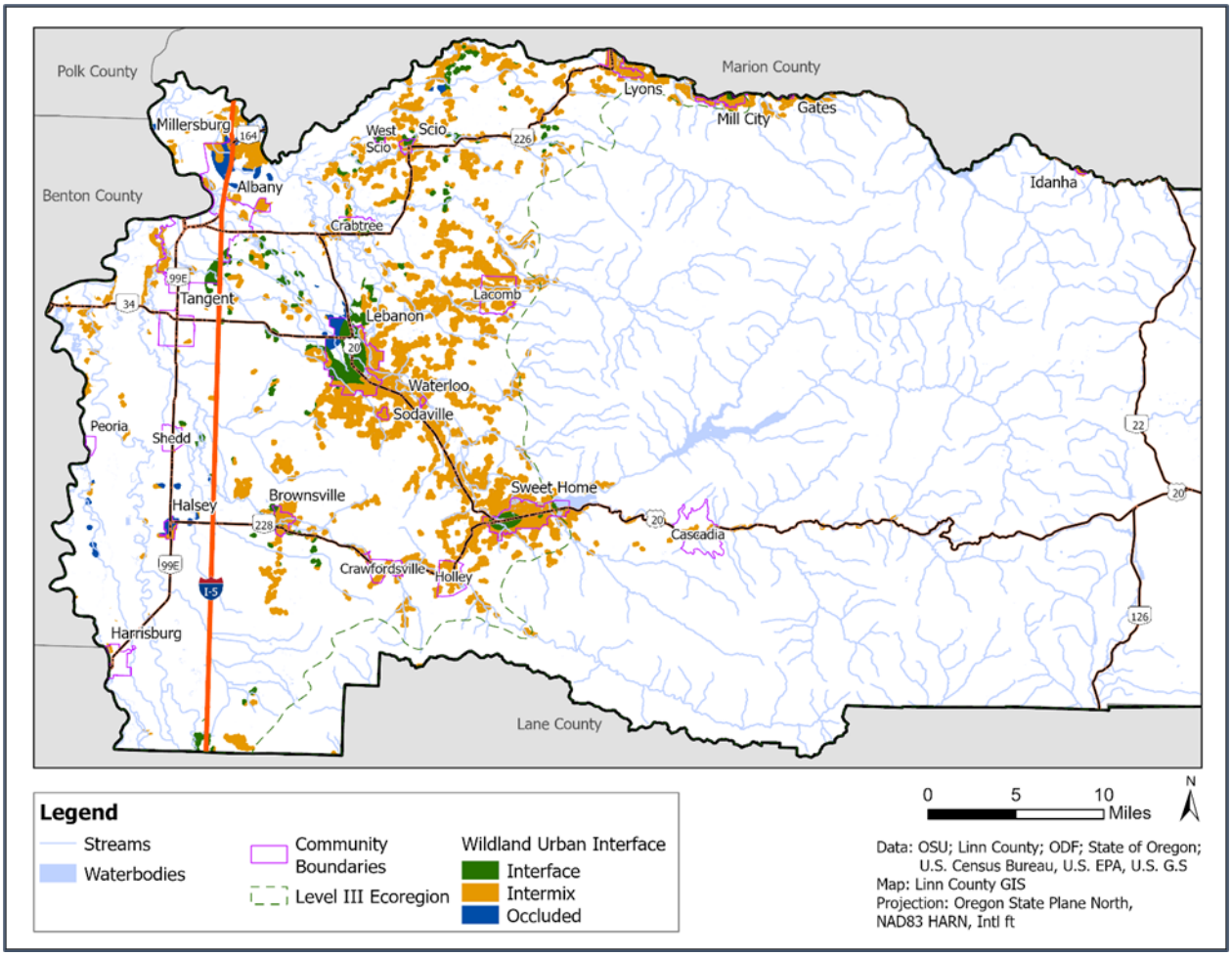
*Albany provides services to Millersburg.
**ODF Districts overlap with various rural fire protection districts.
Source: Linn County CWPP, 2024. For more information regarding the data set, see the CWPP's Appendix B: Risk Assessment Methods.

Fire susceptibility throughout the county dramatically increases in late summer and early autumn as summer thunderstorms with lightning strikes increase and vegetation dries out. In

late summer and early fall plant moisture is decreasing and the ratio of dead fuel to living fuel is increasing.

Other factors, including humidity, wind speed and direction, fuel load and fuel type, and topography can contribute to the intensity and spread of wildland. In addition, common causes of wildfires include negligence from forestry operations, industrial or agricultural activities, and recreational activities.

Figure 2-29. Linn County Wildland Urban Interface Map



Source: Linn County CWPP, 2024

History

While Linn County regularly experiences wildfires, these have not had significant effects on communities until recently. The catastrophic 2020 Labor Day fires greatly impacted the north part of Linn County. The 2023 Priceboro and Wiley Fires in the south part of the county resulted in resident evacuations and area closures but no loss of life or structures.[45] [46] Much of Linn

[45] https://kpic.com/news/local/firefighters-push-back-against-priceboro-fire-evacuation-remains-in-effect
[46] https://www.linncountyor.gov/sites/default/files/fileattachments/board_of_commissioners/page/4141/sept2023.pdf

County has also been impacted by smoke and road and area closures from these fires and fires in adjacent counties, impacting public health, recreation, and local economies.

Between January 2014 and November 2023, ODF reported that the North Cascade District (Santiam Unit) experienced a total of 236 fires burning a total of 399,027 acres, including the 2020 Lionshead and Beachie Creek Fires, which burned 204,474 acres and 193,566 acres respectively. For the South Cascade District (Sweet Home Unit), ODF reported a total of 215 fires burning a total of 635 acres, including the 2023 Priceboro and Wiley Fires, which burned 309.5 acres and 244 acres respectively.[47]

There have been seven significant wildfire events since the previous plan, and additional historical wildfire information specific to Linn County has been added (as shown in *italics* below):[48]

- ***1960 – 1970:*** *ODF reports a total of 327 fires in South Cascade District 77 (Sweet Home Unit), burning a total of 2,213.9 acres. While most of these fires were tiny, the largest burned 598 acres in 1966.*
- ***1971 – 1980:*** *ODF reports a total of 241 fires in South Cascade District 77 (Sweet Home Unit), burning a total of 2,856.45 acres. While most of these fires were tiny, the largest burned 837 acres in 1980.*
- ***1981 – 1990:*** *ODF reports a total of 191 fires in South Cascade District 77 (Sweet Home Unit), burning a total of 2,934.9 acres. While most of these fires were tiny, the largest burned 2,023 acres in 1987.*
- ***1991 – 2000:*** *ODF reports a total of 2 fires in North Cascade District 58 (Santiam Unit), burning a total of 0.13 acres. ODF reports a total of 251 fires in South Cascade District 77 (Sweet Home Unit), burning a total of 260.2 acres. While most of these fires were tiny, the largest, the Thomas Creek Fire, burned 70.1 acres in 1998.*
- ***2001 – 2010:*** *ODF reports a total of 41 fires in North Cascade District 58 (Santiam Unit), burning a total of 65.2 acres. ODF reports a total of 257 fires in South Cascade District 77 (Sweet Home Unit), burning a total of 1,426.68 acres. While most of these fires were tiny, the largest, the Middle Fork Fire, burned 1,070 acres in 2006.*
- ***2012:*** *Hilltop Fire burned 16.5 acres in South Cascade District 77 (Sweet Home Unit).*
- ***2014:*** *Gates Complex (GM) Fire, burned 35 acres in North Cascade District 58 (Santiam Unit).*
- ***2014:*** *7 Mile Fire, burned 45 acres in North Cascade District 58 (Santiam Unit).*
- ***2020:*** *Beachie Creek Fire burned 193,566 acres in North Cascade District 58 (Santiam Unit) (FEMA FM-5356)*
- ***2020:*** *Lionshead Fire burned 204,474 acres in North Cascade District 58 (Santiam Unit) (FEMA FM-5356)*
- ***2020:*** *Green Peter Peninsula Fire burned 18 acres in South Cascade District 77 (Sweet Home Unit)*
- ***2020:*** *W. Brush Creek Fire burned 13.6 acres in South Cascade District 77 (Sweet Home Unit)*

2023 Lookout Fire, Source: Linn County Emergency Management staff

[47] Linn County Community Wildfire Protection Plan, 2024.
[48] Ibid.

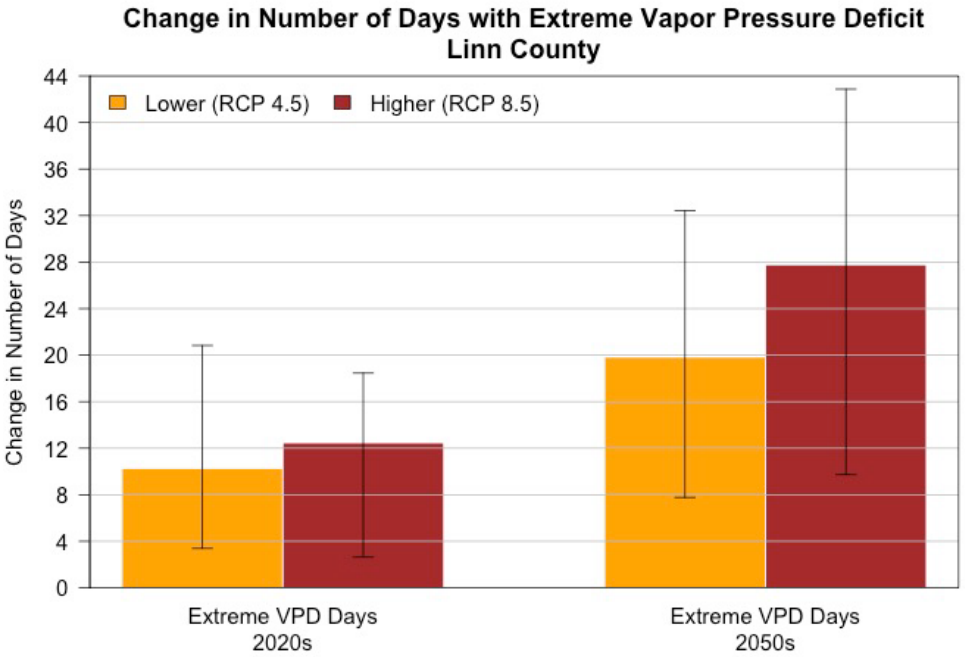
- ***2023:*** *Lookout Fire burned at least 25.751 acres in the HJ Andrews Experimental Forest*
- ***2023:*** *Priceboro Fire burned 309.5 acres in South Cascade District 77 (Sweet Home Unit)*
- ***2023:*** *Wiley Fire burned 244 acres in South Cascade District 77 (Sweet Home Unit)*

Probability Assessment

Certain conditions must be present for significant interface fires to occur. The most common are hot, dry, and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, several conditions influence its behavior, including fuel, topography, weather, drought, and development.

OCCRI analyzed the factors that may contribute to future conditions for wildfire occurrence in the 2023 Future Climate Projections report available in Appendix F to this plan. Based on this analysis wildfire frequency and area burned are projected to continue increasing in the Northwest, and wildfire intensity is projected to increase. Wildfire risk, expressed as the average number of days per year on which fire danger is very high, is projected to increase in Linn County by 12 days (range -6–31) by the 2050s. The average number of days per year on which vapor pressure deficit is extreme is projected to increase by 28 (range 10–43) by the 2050s.

Figure 2-30. Change in Number of Days with Extreme Vapor Pressure Deficit in Linn County



Source: OCCRI, Future Climate Projections Linn County, Oregon, July 2023

Based on the available background and experience of members of the Linn County NHMP Steering Committee, the group determined that the **probability of experiencing a wildfire is "high,"** meaning one incident is likely within the next 10 – 35-year period. *This rating has not changed since the previous plan*.

Vulnerability and Impacts

The overall economic, environmental, and social impacts to the people and assets in Linn County from wildfire are wide ranging. In addition to loss of life and injury, direct impacts to property lead to short- and long-term displacement of people and business closures with associated financial costs. Critical facilities, infrastructure, and lifelines can be impacted, including transportation, utilities (e.g., gas, electric, water, sewer, and communications), food distribution, emergency response and medical services, and more. Some water systems may not have sufficient pressure to allow for use of multiple fire hydrants in more developed areas or water intakes may be damaged, disrupting water supply. Loss of power during a fire as well as from public safety power shut offs, a pre-emptive action to power down the electric grid during Red Flag Warnings, can impact people with medical issues and other services that rely on electricity. Additionally, loss of electricity can compromise firefighting capacity if water supplies that fire agencies depend on to refill fire engines do not have back up power supply. Cellphone towers may also be impacted by wildfire, interrupting the ability of local emergency managers to effectively broadcast evacuation and other emergency notices to community members.

Ecosystems, including the services they provide such as clean air and water, and wildlife habitat can be adversely affected by fire. Commercial logging operations in the forested eastern part of Linn County are vulnerable to wildfire, with associated economic repercussions if timber stands are lost or roads are impacted. Outdoor recreation in the forested areas of Linn County can also be impacted by wildfire, which can force area closures and impact tourism and related businesses. Wildifre smoke and poor air quality can impact people, agriculture, and the economy far beyond the fire location, further discussed in the smoke and air quality section of this plan. Post-fire debris flows are another fire-related impact; landslides are further discussed in the landslide hazard section of this plan. Given current available data, it is beyond the capability of Linn County to assess all of these broader vulnerabilities and impacts at this time.

The DOGAMI Multi-Hazard Risk Report for Linn County, included as Appendix E, analyzed the exposure of people and structures to the highest hazard category for wildfire. The High hazard category was chosen as the primary scenario for this report because it represents areas that have the highest potential for losses. However, Low hazard is not the same as no hazard. Moderate wildfire risk is included with high risk in the assessment of exposure, because under certain conditions moderate risk zones can be very susceptible to burn. In combining the High and Moderate risk categories within Linn County, DOGAMI's report emphasizes areas where lives and property are most at risk.

Linn Countywide wildfire exposure (High or Moderate Risk):
- Number of buildings: 3,871
- Value of exposed buildings: $811,012,000
- Percentage of total county value exposed: 3.1%
- Critical facilities exposed: 6 of 154
- Potentially displaced population: 4,419

Source: DOGAMI Multi-Hazard Risk Report, 2024

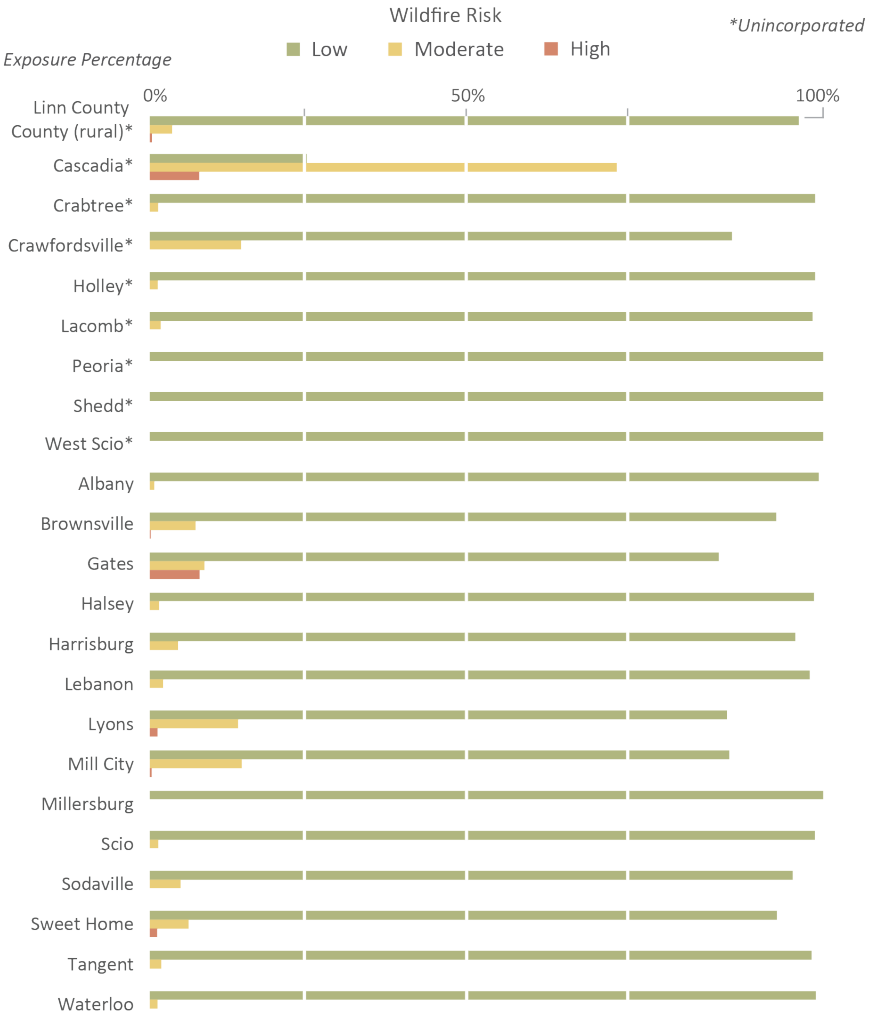
For DOGAMI's risk assessment, the building locations were compared to the geographic extent of the wildfire risk categories. More than 3,800 buildings in the heavily forested parts of central and eastern Linn County are exposed to High or Moderate wildfire hazard (see Appendix E, Plate

10). Portions of heavily forested areas in Linn County, where the communities of Cascadia, Crawfordsville, Gates, Lyons, Mill City, and Sweet Home are located, have the highest percentage of exposure to High and Moderate wildfire hazard within the study area, as shown in Figure 2-31, below.

The DOGAMI analysts identified locations within the study area that are comparatively at greater risk to wildfire hazard:

- Portions of Linn County that are at greatest risk from wildfires are primarily along the North Santiam River, which includes the communities of Lyons, Gates, and Mill City (and Idanha).
- The entire heavily forested eastern half of Linn County (the Cascades) is at moderate to high risk from wildfire. Very little development is present in these areas with the exception of the community of Cascadia.

Figure 2-31. Wildfire Risk Exposure by Linn County Community



Source: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon, 2024

The 2024 Linn County CWPP identified that there was a gap in vulnerability analysis within the 2007 CWPP related to consideration for the vulnerability of certain populations in Linn County, including the elderly, disabled, low income, and non-English speaking residents who many may not have the physical, financial, or informational resources for wildfire preparedness and evacuation activities. These conditions are often referred to collectively as social vulnerability. Social vulnerability is a combination of factors that may weaken a community's ability to prevent human suffering and/or financial loss in a disaster situation. It is measured using a Social Vulnerability Index (SVI). At the time of the 2007 report, the State of Oregon did not have an SVI developed specifically for evaluating the vulnerability of populations to wildfire.

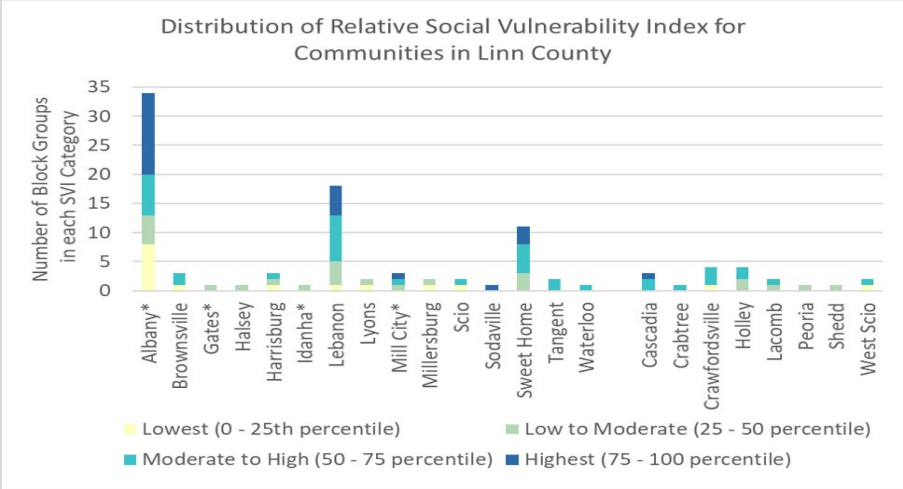
In 2021, Oregon Senate Bill 762, the wildfire omnibus bill, directed OSU to develop a statewide map of social vulnerability. The resulting Social Vulnerability Index (SVI) map depicts how socially vulnerable a place is by considering various factors within the local population, such as the poverty rate, household age and disability composition, access to transportation, unemployment, limited English language skills, and other factors.[49] The SVI combines these indicators to create a single score for each area which is then ranked relative to all other areas in Oregon, for this study, of the same census type. The SVI helps illustrate the likelihood that one place is more socially vulnerable compared to other places in the state. Social vulnerability is mapped at a census block group scale for this study. For more information about the methods for developing the statewide SVI, see the Linn County CWPP, Appendix B: Risk Assessment Methods.

The following communities in Linn County contain one or more block group assessed at the highest social vulnerability: Albany, Lebanon, Mill City, Sodaville, Sweet Home, and Cascadia.

There is noticeable overlap of highly socially vulnerable communities with areas that have higher relative wildfire risk ratings - particularly in or near Cascadia, Mill City, Sweet Home, and Sodaville. Socially vulnerable communities should be prioritized for wildfire mitigation resources, particularly homeowner assistance programs and other grants or cost-share opportunities when possible. However, it is important to caveat this recommendation as the SVI uses demographic data from the US Census American Community Survey 5-year estimates from 2018-2022. This source may not capture the full social impact of major events such as the 2020 wildfire season and COVID-19 pandemic on communities in Linn County - particularly within the Santiam Canyon. Other factors should be considered on a case-by-case basis to identify socially vulnerable communities, using the best available demographic and economic data.

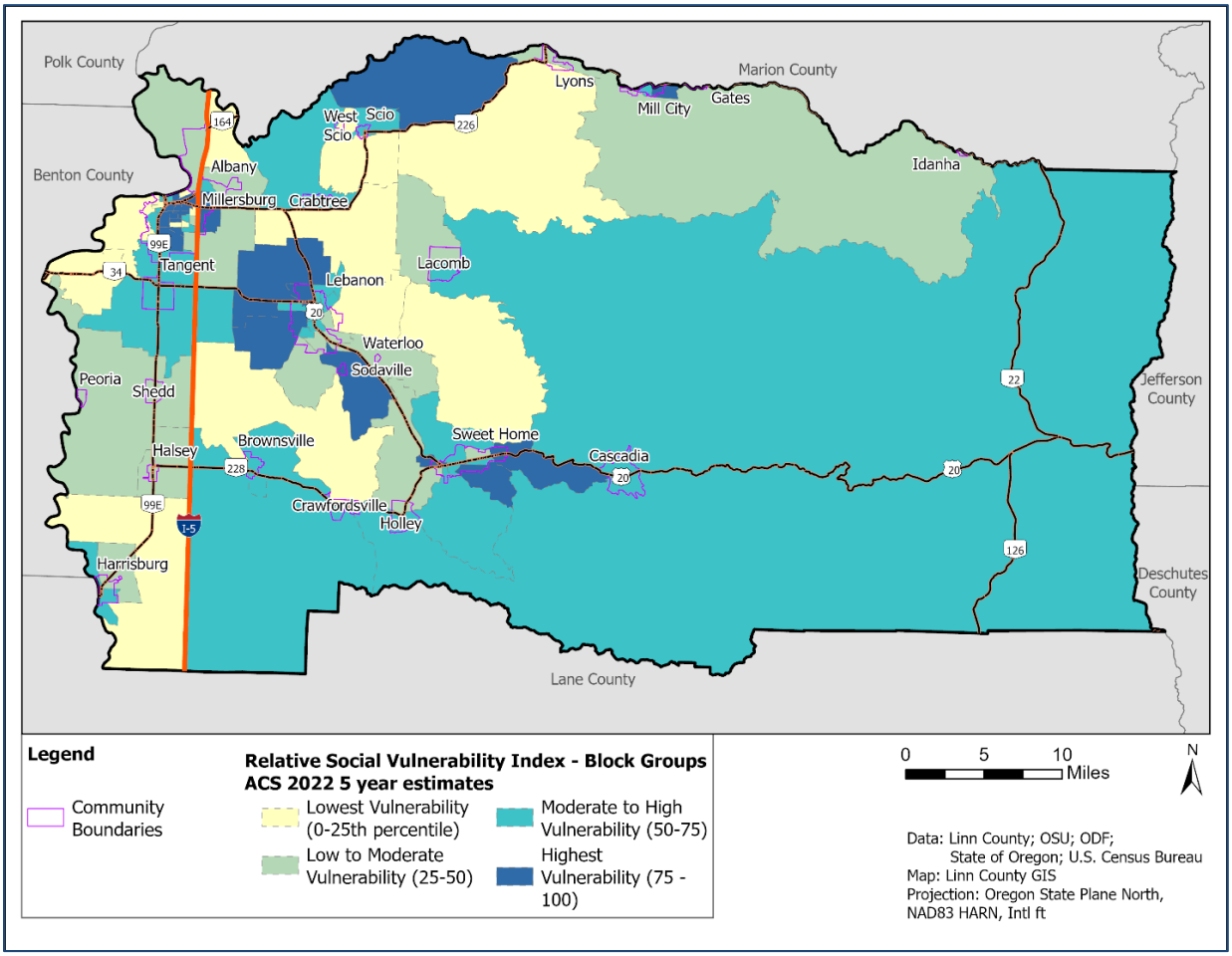
[49] Mapping socially vulnerable communities, Oregon State University College of Forestry, https://oe.oregonexplorer.info/externalcontent/wildfire/metadata/Overview_SVI_SB762.pdf

Figure 2-32. Distribution of Social Vulnerability Index for Linn County Communities



*Communities with boundaries that span multiple counties; only block groups from Linn County are included.
Source: Linn County Community Wildfire Protection Plan, 2024

Figure 2-33. Linn County Overall Social Vulnerability Map



Source: Linn County Community Wildfire Protection Plan, 2024

Based on the background and experience of the NHMP Steering Committee members and data provided in the CWPP, the group used the OEM-FEMA Hazard Analysis Methodology and rated the county as having a **"moderate" vulnerability to wildfire hazards.** *This rating has not changed since the previous plan*.

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley of the Oregon NHMP (2020) and future updates.

Severe Weather: Extreme Heat, Windstorms/Tornadoes, and Winter Storms/Ice Storms

Significant Changes Since Previous Plan:

Extreme Heat was added as a new hazard of concern to the list of Severe Weather natural hazards addressed in this mitigation plan. Additionally, Tornado was added to Windstorm and Ice Storm was added to Winter Storm in this update.

The Severe Weather Hazard has been edited to detail new history since the 2017 Linn Plan.

The NHMP Steering Committee assessed the probability of an Extreme Heat event as "high" and the vulnerability of county's residents to Extreme Heat as "high."

The NHMP Steering Committee ranked the probability of Windstorm and Tornado as "moderate," reduced from the ranking given in the previous plan. The Committee rated the county as having a "moderate" vulnerability to Windstorm and Tornado hazards, unchanged since the previous plan.

The NHMP Steering Committee ranked the probability of experiencing a Winter Storm or Ice Storm as "high," unchanged since the previous plan. The Committee rated the county as having a "high" vulnerability to Winter Storm and Ice Storm hazards, also unchanged since the previous plan.

Extreme Heat

The Linn County Steering Committee discussed the recent increase in extreme heat events and determined that it was very important to add this natural hazard to the list of hazards addressed in this NHMP. Part of the reason for this addition is the deadly nature of this hazard and the potential to reduce impacts to vulnerable people through mitigation measures. The impact of climate change on this hazard is direct and related to climate change mitigation efforts as well.

In the period since 2017 there have been two excessive heat events and three high heat events in Linn County.

Characteristics

Extreme heat can refer to days on which maximum or minimum temperatures are above a threshold, seasons in which temperatures are well above average, and heat waves, or multiple days on which temperature are above a threshold. OCCRI's report presents projected changes in

the metrics of extreme daytime heat (maximum temperature) and nighttime heat (minimum temperature), defined below in Figure 2-34.

Figure 2-34. Metrics and Definitions of Heat Extremes

Metric	Definition
Hot Days	Number of days per year on which maximum temperature is 90°F or higher
Warm Nights	Number of days per year on which minimum temperature is 65°F or higher
Hottest Day	Highest value of maximum temperature per year
Warmest Night	Highest value of minimum temperature per year
Daytime Heat Waves	Number of events per year in which the maximum temperature on at least three consecutive days is 90°F or higher
Nighttime Heat Waves	Number of events per year in which the minimum temperature on at least three consecutive days is 65°F or higher

Source: Future Climate Projections Linn County, Oregon, OCCRI, September 2023

Location and Extent

Extreme heat can refer to extremely warm daytime highs or overnight lows (days on which maximum or minimum temperatures are above a threshold or a probability relative to past decades), seasons in which temperatures are well above average, and heat waves, or multiple consecutive days on which maximum or minimum temperatures are above a threshold or a probability. In the Pacific Northwest, a day on which the maximum temperature is at least 90°F is often considered to be an extremely warm day. The number of such days increased significantly across Oregon since 1951 (O'Neill et al., 2023).[50]

History

In the period since 2017 there have been two Excessive Heat events in Linn County. See the Storm Events Database provided by NOAA for more information.[51]

Excessive Heat events include:

- **June 26-29, 2021**: A high-pressure heat dome over the region led to stretch of extreme heat, shattering records from June 26 through June 29. All time maximum temperatures were broken by 8 to 10 degrees. Widespread fatalities occurred due to the heat, 123 in total in Oregon, as many were without air-conditioning, as well as an increase in the number of drownings. Widespread closures and postponements of businesses and events also occurred. [52]

  There were three consecutive days with maximum temperatures greater than 100 degrees measured at several stations. The hottest day was June 28 when temperatures

[50] OCCRI Future Climate Projections, Linn County, Oregon, 2023, included as Appendix F of this NHMP.
[51] NOAA Storm Event database, http://www.ncdc.noaa.gov/stormevents/.
[52] Ibid.

peaked around 112 degrees. The minimum temperatures were warm as well with nighttime temperatures in the 70s on June 27 and June 28.

- **August 11-12, 2021**: Hot weather began to develop August 9, peaking August 11-12, but temperatures continued above normal into the weekend. Peak afternoon temperatures of 100 to 105 degrees drove people to seek relief in or near bodies of water. High Heat days on July 29 and August 18 bracketed this event with daytime temperatures in the high 90's and nighttime temperatures in the 60's.

High Heat days in 2017, 2021, and 2022 include:

- **May 21-22, 2017:** In the North Cascades region of the county a ridge of high pressure brought a couple days of warm weather. While air temperatures were warm, river and lake temperatures were still cold, leading to two drownings across the area.
- **July 29, 2021**, a strong high pressure aloft brought a brief hot air mass to the region. The Oregon Governor issued an Emergency Declaration due to forecasted heat across the State affecting 23 counties. On July 29th the high temperature at the KEUG ASOS was 99 degrees Fahrenheit. Temperatures in the area peaked in the mid and upper 90s.
- **August 17, 2022:** High temperatures on the 17th were in the mid to upper 90s. For example, the high temperature near Eugene at Mahlon Sweet Field (KEUG) was 97 degrees. Overnight temperatures were quite warm with lows in the 60s.

Probability Assessment

OCCRI's analysis concluded that in Linn County, the number of hot days and warm nights, and the temperature on the hottest day and warmest night, are projected to increase by the 2020s (2010–2039) and 2050s (2040–2069) under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios.

The analysis is derived from 10–20 global climate models (GMCs) and two scenarios of future global emissions of greenhouse gases. The spatial resolution of projections from global climate models has been refined to better represent local conditions. County-level summaries of changes in climate metrics are projected to the beginning and middle of the twenty-first century relative to a historical baseline. More information about the data sources can be found in the report included as Appendix F.

In Linn County, the number of extremely hot days (days on which the temperature is 90°F or higher) and the temperature on the hottest day of the year are projected to increase by the 2020s and 2050s under both the lower and higher emissions scenarios.

The number of days per year with temperatures 90°F or higher is projected to increase by an average of about 17 days (range 5-29 days) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario. The average historical baseline is 4 days.

The temperature on the hottest day of the year is projected to increase by an average of about 6.8°F (range 1.9-9.8°F) by the 2050s relative to the GCMs' historical baselines. The average projected increase in temperature on the hottest day is 6.8°F above the average historical baseline of 91.4°F.

The average number of warm nights per year by the 2050's under the higher emission scenario is projected to be about 4 more than the average historical baseline of close to zero. The

average projected increase in temperature on the warmest night is 5.8°F above the average historical baseline of 61.3°F.

Under the higher emissions scenario, the numbers of daytime and nighttime heat waves are projected to increase by 0.8–3.4 and 0.0–1.8, respectively, by the 2050s relative to the GCMs' historical baselines. The average number of daytime and nighttime heat waves is projected to increase by 2.5 and 0.5, respectively, above the average historical baselines of 0.5 and zero.

The table below shows these data for Linn County from the OCCRI report.

Table 2-7. Projected Future Changes in Extreme Heat Metrics in Linn County

	Average Historical Baseline	2020s		2050s	
		Lower	Higher	Lower	Higher
Hot Days	3.7 days	4.2 days (1.6-7.4)	5.8 days (2.5-8.3)	10.6 days (4.5-17.5)	17.4 days (4.9-28.6)
Warm Nights	0.3 days	0.5 days (0-1.3)	0.7 days (0-1.5)	1.7 days (0.1-4.5)	3.8 days (0.8-10.3)
Hottest Day	91.4°F	2.5°F (0.6-4)	3.2°F (1.1-5.4)	5.1°F (2.1-8.6)	6.8°F (1.9-9.8)
Warmest Night	61.3°F	2°F (0-3.8)	2.5°F (0.9-3.6)	4°F (1.2-6.8)	5.8°F (2.6-8.8)
Daytime Heat Waves	0.5 events	0.7 events (0.2-1.2)	0.9 events (0.4-1.4)	1.6 events (0.8-2.5)	2.5 events (0.8-3.5)
Nighttime Heat Waves	0 events	0 events (0-0.2)	0.1 events (0-0.2)	0.2 events (0-0.5)	0.5 events (0-1.3)

Source: OCCRI, Future Climate Projections, Linn County, Oregon, 2023

Based on the participants' background and experience in Linn County the NHMP Steering Committee assessed the **probability of an extreme heat event as "high,"** ranked 8.4 out of 10 for this factor meaning one incident is likely in their view within a 10-to-35-year period.

Vulnerability and Impacts

Extreme heat can result in heat-related illness and death due to heat stroke, especially for vulnerable populations. In terms of the potential effects of extreme heat on people, certain populations are considered especially vulnerable to heat-related illness and death; extreme heat also exacerbates interpersonal violence (Miles-Novelo and Anderson, 2019; Stechemesser et al., 2022). Vulnerable populations include agricultural, forestry, and other outdoor workers; residents of urban heat islands; people with preexisting conditions or without housing or air conditioning; pregnant women; older adults; children; low-income communities; and communities of color (York et al., 2020; Ho et al., 2021).[53]

[53] OCCRI Future Climate Projections, Linn County, Oregon, 2023, see Appendix F of this NHMP.

Injury or death can also occur when residents seek relief in bodies of water. During the August 11-12, 2021, extreme heat event, a 22-year-old woman drowned after being swept away while wading in the Willamette River near the pedestrian bridge between the University of Oregon campus and Autzen Stadium in Eugene. The high temperature at Eugene (KEUG) was 102 degrees on the 11th and 104 degrees on the 12th. Cooling shelters were opened in several counties during the June 2021 extreme heat event. Nevertheless 123 people lost their lives. Multnomah County had the largest number of fatalities in the state of Oregon with 73 deaths directly related to the heat.

Many homes in Linn County are poorly insulated and lack air conditioning, increasing the need for public cooling spaces and shelters. Additionally, many public school buildings in the county are not air conditioned, resulting in the need to cancel school on days with extreme heat, which can impact learning as well as necessitate a parent or guardian having to leave work to tend to younger children. Outdoor events, including cultural activities, may also be cancelled during extreme heat events, leading to financial impacts to organizers and vendors.

Extreme heat can also impact infrastructure, especially due to malfunction of equipment not designed for extremes, and strain power, water, and transportation systems, leading to outages and disruptions. During the 2021 heat dome event, heat caused slowdowns on the MAX light rail in the Portland metro area, and some businesses closed due to the heat. Increased demand for electricity for space cooling during extreme heat events, for example, can strain the electric grid, potentially leading to power outages.

Agriculture and the natural environment are also vulnerable to extreme heat, which can be a factor in drought, discussed further in the drought section of this plan. Extreme heat can damage crops, reducing yields, and impact tree health in communities. Extreme heat can also impact ecosystems, such as increasing stream temperatures adversely impacting fish habitat and drying out forests and other vegetation, increasing wildfire risk.

Given current available data, no quantitative assessment of the risk of extreme heat was possible at the time of this NHMP update to determine vulnerability. However, assessing the risk to the County's people and assets from extreme heat should remain an ongoing process determined by community characteristics and physical vulnerabilities. The County has added a new multi-hazard action item to evaluate vulnerability of and impacts to community assets from extreme heat where feasible.

Using the OEM-FEMA Methodology and based on participants' background and experience, the NHMP Steering Committee rated the county's residents as having a **"high" vulnerability to an Extreme Heat** event representing 1-10 % of the population being affected. Steering Committee members ranked the relative vulnerability of Linn County residents to an Extreme Heat event, they ranked the hazard at 5.9 out of 12, a moderate ranking.

More information on this hazard can be found in the OCCRI report included in Appendix F of this NHMP and in the Risk Assessment for Region 3, Mid-Willamette Valley of the Oregon NHMP (2020) and future updates.

Windstorm/Tornado

Characteristics

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Per the Beaufort Wind Scale,[54] winds in excess of 50 mph are classified as follows:

Force	MPH	Description
9	47-54	Severe Gale
10	55-63	Storm
11	64-72	Violent Storm
12	72-83	Hurricane

The most persistent high winds take place along the Oregon Coast and in the Columbia River Gorge. High winds in the Columbia Gorge are well documented. The Gorge is the most significant east-west gap in the Cascade Mountains between California and Canada. Wind conditions in central Oregon are not as dramatic as those along the coast or in the Gorge yet can cause dust storms or be associated with severe winter conditions such as blizzards. A majority of the destructive surface winds striking Oregon are from the southwest. Some winds blow from the east but most often do not carry the same destructive force as those from the Pacific Ocean.

Though tornadoes are not common in Oregon, these events do occasionally occur and sometimes produce significant property damage and even injury. Tornadoes are the most concentrated and violent storms produced by earth's atmosphere and can produce winds in excess of 300 mph. They have been reported in most regions throughout the state since 1887. Most of them are caused by intense local thunderstorms common between April and October.

The characteristics of tornadoes are determined by wind speed and event duration. Tornadoes often occur quickly with a duration ranging from several minutes to several hours. The Enhanced Fujita Scale (EF Scale) assigns a tornado rating based on estimated wind speeds and related damages, as follows:[55]

EF Rating	3 Second Gust (mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

Location and Extent

The most common type of wind pattern affecting Linn County is straight-line winds, which originate as a downdraft of rain-cooled air and reach the ground and spread out rapidly. Straight-line winds can produce gusts of up to 100 mph – extending beyond Hurricane (Force 12)

[54] Beaufort Wind Scale, National Weather Service, https://www.weather.gov/mfl/beaufort
[55] Enhanced Fujita Scale, National Weather Service, https://www.weather.gov/oun/efscale

winds per the Beaufort Scale. For Linn County, the wind hazard levels are generally highest near the Willamette River and then fairly uniform across most of the rest of the county. In the mountainous areas, however, the level of wind hazard is strongly determined by local specific conditions of topography and vegetation cover. Mountainous terrain slows down wind movement, which is why Oregon's sheltered valley areas have the slowest wind speed in the state. However, in the foothills, the wind speeds may increase due to down-sloping winds from the mountains.

Most official wind observations in Oregon are sparse, taken at low-elevation locations where both the surface friction and the blocking action of the mountain ranges substantially decrease the speed of surface winds. Furthermore, there are few long-term reliable records of wind available. Even the more exposed areas of the coast are lacking in any long-term set of wind records. From unofficial, but reliable observations, it is reasonable to assume that gusts well above 100 mph occur several times each year across the higher ridges of the Coast and Cascades Ranges. At the most exposed Coast Range ridges, it is estimated, that wind gusts of up to 150 mph and sustained speeds of 110 mph will occur every 5–10 years.[56]

Although windstorms and tornados can affect the entirety of the county, they are especially dangerous in developed areas with significant tree stands and major infrastructure, especially above ground utility lines. A windstorm will frequently knock down large trees and power lines, damage homes, businesses, public facilities, and create tons of storm related debris. Hurricane-force winds can overturn mobile homes.[57] The extent of past tornadoes in the county is included below. The probability of a major tornado occurring in Linn County is uncertain due to limited historical records.

History

Windstorms occur yearly; more destructive storms occur once or twice per decade, most recently in December 2015 and September 2020. The following windstorms and tornados have occurred within, and/or near Linn County. Three windstorm events and two tornado events were added to this hazard history section since the previous plan (shown in *italics* below)[58]:

- **Jan. 1880:** Coast and Willamette Valley, In Portland, sustained south wind speeds of 60 mph were observed. Elsewhere, south winds were reported as high as 65 mph with gusts to 80 mph. Thousands of trees, many five to eight feet in diameter, were easily toppled in the high winds. Buildings throughout the Willamette Valley were destroyed. Hundreds more, including numerous large public buildings, were severely damaged.
- **Jan. 1921:** Coast and Willamette Valley, Hurricane-force winds were reported along the entire Oregon and Washington coasts. 113 mph was officially recorded at the north head of the mouth of the Columbia River on the Washington side. Very strong winds were also reported in the Willamette Valley. Widespread damage to buildings and standing timber.

[56] Draft Oregon Natural Hazards Mitigation Plan, 2025.
[57] National Weather Service, https://www.weather.gov/ilx/swopwindscale
[58] Taylor, George H., and Ray Hatton, 1999, The Oregon Weather Book; The Spatial Hazard Events and Losses Database for the United States, [Online Database]. Columbia, SC: University of South Carolina. Available at http://www.sheldus.org; U.S. Department of Commerce. National Climatic Data Center. Available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms; National Weather Service Forecast Office. Available at http://www.wrh.noaa.gov/pqr/paststorms/wind.php.

- **Apr. 1931:** Western Oregon, unofficial wind speeds reported at 78 mph. Damage to fruit orchards and timber.
- **Nov. 10-11, 1951:** Statewide, widespread damage; transmission and utility lines; Wind speed 40-60 mph; Gusts 75-80 mph
- **Dec. 1951:** Statewide, wind speed 60 mph in Willamette Valley. 75 mph gusts. Damage to buildings and utility lines.
- **Dec. 1955:** Statewide, Wind speeds 55-65 mph with 69 mph gusts. Considerable damage to buildings and utility lines
- **Nov. 1958:** Statewide, Wind speeds at 51 mph with 71 mph gusts. Every major highway blocked by fallen trees
- **Oct. 1962:** Statewide, *Columbus Day Storm*; Oregon's most destructive storm to date. 116 mph winds in Willamette Valley. Estimated 84 houses destroyed, with 5,000 severely damaged. Total damage estimated at $170 million
- **Oct. 1967:** Statewide, Significant widespread damage occurred to agriculture, timber, power and telephone utilities, and homes. Portland airport recorded a fastest mile of 70 mph. Wind speeds of 100 to 115 mph were unofficially recorded along the Oregon coast. There was one fatality and about 15 persons were seriously injured.
- **Mar. 1971:** Most of Oregon, Greatest damage in Willamette Valley. Homes and power lines destroyed by falling trees.
- **Nov. 1981:** Most of Oregon, highest winds since 1962. Wind speed 71 mph in Salem. Marinas, airports and bridges severely damaged.
- **Jan. 1990:** Statewide, Heavy rain with winds exceeding 75 mph. Significant damage, and one fatality.
- **Dec. 1996:** Statewide, Followed path of Columbus Day Storm. Wind speeds 62 mph in Willamette Valley. Damage to trees (saturated soil a factor) and homes. (FEMA-1107-DR-OR)
- **Nov. 1997:** Western Oregon, Wind speed 52 mph in Willamette Valley. Trees uprooted. Considerable damage to small airports.
- **Feb. 2002:** Western Oregon, Strongest storm to strike western Oregon in several years. Many downed power lines (trees); damage to buildings; water supply problems (lack of power). Estimated damage costs: $6.14 million. (FEMA-1405-DR-OR)
- **Jan. 2005:** Windstorms caused $6,000 of damage in Linn and Marion Counties. A storm total of $15,000 in damages spread out among Linn, Marion, Clackamas, Multnomah, and Washington Counties.
- **Dec. 15, 2005:** Willamette Valley, a decent windstorm moved up the Willamette Valley bringing strong winds to the central and southern valley. $3,000 in property damage in Linn and Marion Counties.
- **Feb. 2006:** Linn, Marion, Lane, Benton, Polk, Yamhill, windstorms with gusts up to 77 mph causes $227,000 in damages in Linn, Lane, Marion, Benton, Polk, and Yamhill Counties.
- **Dec. 1-3, 2007:** Oregon and Washington, a relentless storm pummeled the Oregon and Washington Coasts for 3 days bringing the strongest winds the area has seen since the Columbus Day storm.
- **Jun. 2009:** Willamette Valley, series of storms brought high winds, thunderstorms, rain, and hail.
- **Jan. 2012:** Severe winter storm, landslides, mudslides, flooding, including high winds (FEMA-4055-DR-OR)

- **Feb. 2014:** Coast and Willamette Valley, severe winter storm including high winds (FEMA-4169-DR-OR)
- **Dec. 2015:** Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides. (FEMA-4258-DR-OR)
- ***Sept. 2017:*** *An EF1 tornado touched down along Green Mountain Road near Lacomb on September 19. Although the tornado appeared to not be on the ground the entire path, the damage path appears to be 0.69 miles long. The tornado damaged five open barns, damaged 5 to 10 plus additional sheds or barns, brought down two power poles, and snapped six trees 4-12 inches in diameter. There were no injuries.*
- ***April 2018:*** *A strong low pressure system tracking northeast towards Vancouver Island generated strong winds along the Coast and in the Willamette Valley. An observer east of Stayton reported a power outage. A weather station in Mill City reported wind gusts up to 57 mph, classified as Storm (Force 10) winds on the Beaufort Scale.*
- ***Sept. 2020:*** *After a period of upper-level ridging brought a return to above normal temperatures in early September, very strong easterly downslope and offshore winds off the Cascades and Coastal Ranges occurred. Winds increased rapidly during the afternoon and evening of September 7 with the passage of an unseasonably strong backdoor cold front and persisted through much of the following day. This resulted in extremely critical fire weather conditions. Widespread wind gusts from 50-70 mph, classified as Storm (Force 10) and Violent Storm (Force 11) winds on the Beaufort Scale, were common on ridge tops and numerous other in exposed areas, including portions of the greater Portland metro area, the Willamette Valley, and areas of the Oregon coast. Strong winds caused widespread damage to trees, and downed numerous power lines across the region, which started at least 13 additional wildfires. (FEMA DR-4562)*
- ***Dec. 2022:*** *A strong frontal system with south winds. Peak gusts of 60 mph, classified as Storm (Force 10) winds on the Beaufort Scale, were measured in Lyons.*
- ***June 2023:*** *A brief, weak tornado (EF0) touched down about 5 miles east of Harrisburg, OR, on June 18 and moved east-northeast across I-5 before dissipating. No damage was reported from this tornado.*

Several additional windstorm events with Strong Winds have occurred since the previous plan; see the NOAA Storm Events Database for more information.[59]

Probability Assessment

Windstorms in the county usually occur in the winter from October to March, and their extent is determined by their track, intensity (the air pressure gradient they generate), and local terrain. Summer thunderstorms may also bring high winds along with heavy rain and/ or hail. The National Weather Service uses weather forecast models to predict oncoming windstorms and monitoring storms as they develop with weather stations in protected valley locations throughout Oregon.

Table 2-8 shows the wind speed probability intervals that structures 30 feet above the ground would expect to be exposed to within a 25, 50, and 100-year period. The table shows that structures in Region 3, which includes Linn County, can expect to be exposed to 60 mph winds in a 25-year recurrence interval (4% annual probability).

[59] NOAA Storm Event database, http://www.ncdc.noaa.gov/stormevents/.

Table 2-8. Probability of Severe Wind Events (Region 3)

	25-Year Event (4% annual probability)	50-Year Event (2% annual probability)	100-Year Event (1% annual probability)
Region 3: Mid/Southern Willamette Valley	60 mph	68 mph	75 mph

Source: Oregon State Natural Hazard Mitigation Plan, 2020

Based on the background and experience of the Linn County the NHMP Steering Committee members, the group ranked that the **probability of experiencing a windstorm or tornado is "moderate,"** 5.6 out of 10 meaning one incident is likely within the next 35-to-75-year period. *This rating has been reduced from the ranking given in the previous plan*.

Vulnerability and Impacts

Many buildings, utilities, and transportation systems within Linn County are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It is also true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to windstorms and tornadoes include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods of time, impacting emergency operations. In addition, uprooted or shattered trees can down power and other utility lines and effectively bring local economic activity and essential facilities to a standstill unless they are equipped with backup power sources. When trees with shallow or weakened root system are exposed to saturated ground and high winds, trees may be more likely to be blown over. For this reason, trees may be more likely to blow over during the winter when the most rain falls in Linn County.

Given current available data, no quantitative assessment of the risk of windstorm or tornado was possible at the time of this NHMP update to determine vulnerability in terms of explicit types and numbers of existing and future buildings, infrastructure, or critical infrastructure. However, assessing the risk to the County's people and assets from windstorms and tornadoes should remain an ongoing process determined by community characteristics and physical vulnerabilities. Linn County has added a new multi-hazard action item to evaluate vulnerability of and impacts to community assets from windstorms and tornadoes.

As such, based on participants' background and experience the NHMP Steering Committee rated the county as having a **"moderate" vulnerability to windstorm and tornado hazards**, ranked 5.1 out of 10 meaning that between 1% and 10% of the region's population or assets would be affected by a major disaster. T*his rating has not changed since the previous plan*.

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley of the Oregon NHMP (2020) and future updates.

Winter Storms/Ice Storms

Characteristics

Winter storms affecting Linn County are generally characterized by a combination of heavy rains and high winds throughout the county, including ice and snowfall, especially at higher elevations in the Cascades. Heavy rains can result in localized or widespread flooding, as well as debris slides and landslides.

The winter storms that affect Linn County are typically not local events affecting only small geographic areas. Rather, winter storms are usually large cyclonic low-pressure systems that move in from the Pacific Ocean and affect large areas of Oregon and/or the whole Pacific Northwest. These storms are most common from October through March.

Ice storms are comprised of cold temperatures and moisture, but subtle changes can result in varying types of ice formation which may include freezing rain, sleet, and hail. Of these, freezing rain can be the most damaging of ice formations.

Outside of mountainous areas, significant snow accumulations are much less likely in western Oregon than on the east side of the Cascades. However, if a cold air mass moves northwest through the Columbia Gorge and collides with a wet Pacific storm, then a larger than average snow fall may result.

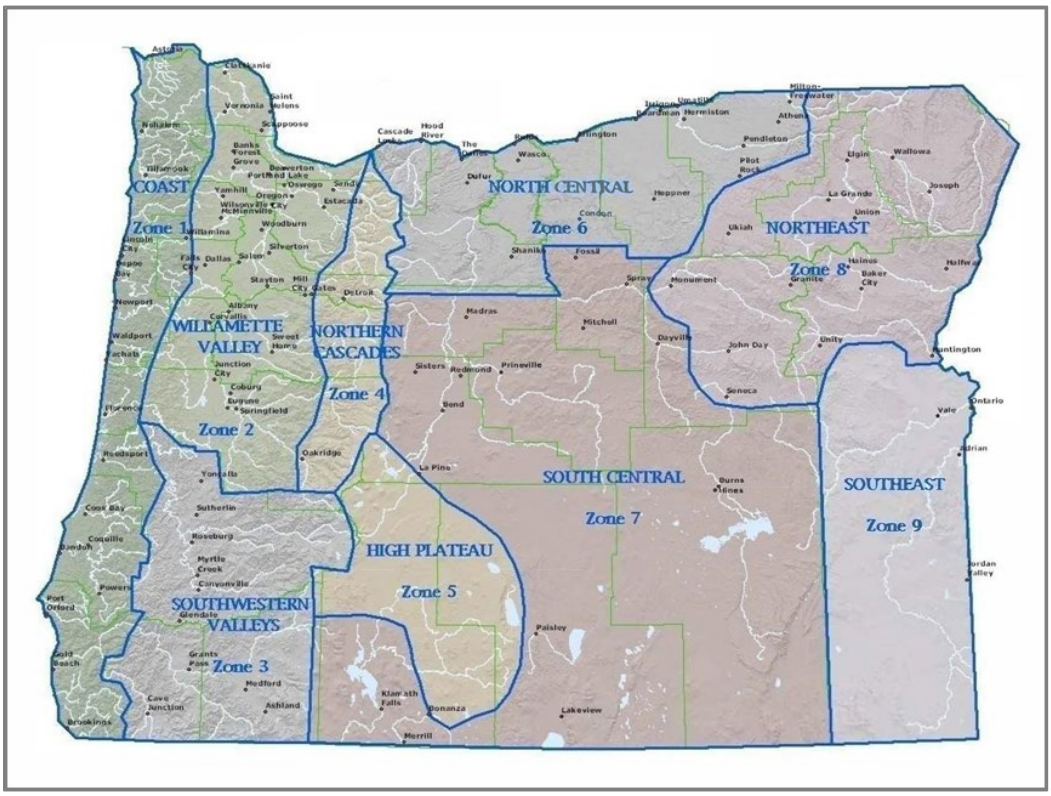
Location and Extent

Ice storms occasionally occur in northern areas of Oregon, resulting from cold air flowing westward through the Columbia River Gorge (Gorge). While sleet and hail can create hazards for motorists when it accumulates, freezing rain can cause the most dangerous conditions within a community. Ice buildup can bring down trees, communication towers, and wires creating hazards for property owners, motorists, and pedestrians alike. The most common freezing rain problems occur near the Gorge. The Gorge is the most significant east-west air passage through the Cascades. Rain arriving from the west can fall on frozen streets, cars, and other sub-freezing surfaces, creating dangerous conditions.

The National Climatic Data Center has established climate zones in the United States for areas that have similar temperature and precipitation characteristics. Oregon's latitude, topography, and proximity to the Pacific Ocean give the state diversified climates. Linn County is located within Zone 2: Willamette Valley and Zone 4: Northern Cascades. The climate in Zone 2 generally consists of cool, wet winters and warm, dry summers.[60] These wet winters result in potentially destructive winter storms that produce heavy snow, ice, rain and freezing rain, and high winds. The climate in Zone 4 generally consists of cold winters with a large amount of snowfall (November – March), cool springs and falls with rain, and warm summers, often punctuated with thunderstorms.[61]

[60] Oregon Climate Service. "The Climate of Oregon: Climate Zone 2: Willamette Valley." Special Report 914. (1993).
[61] Oregon Climate Service. "The Climate of Oregon: Climate Zone 4: Northern Cascades." Special Report 916. (1993).

Figure 2-35. Oregon Climate Divisions



Source: Oregon Climate Service

The principal types of winter storms affecting Linn County include the following:

- Snowstorms require three ingredients: cold air, moisture, and air disturbance. The result is snow, small ice particles that fall from the sky. In Oregon, the further inland and north one moves, the more snowfall can be expected. Blizzards are included in this category.
- Ice storms are a type of winter storm that forms when a layer of warm air is sandwiched by two layers of cold air. Frozen precipitation melts when it hits the warm layer and refreezes when hitting the cold layer below the inversion. Ice storms can include sleet, when the rain refreezes before hitting the ground, or freezing rain, when the rain freezes once hitting the ground.
- Extreme Cold can occur when dangerously low temperatures accompany winter storms. This is particularly dangerous because snow and ice storms can cause power outages, leaving many people without adequate heating.

Winter storms that bring snow and ice can impact infrastructure, business, and individuals. At higher elevations there is more risk of snow and ice, but the entire county can face damage from winter storms and, for example, the hail or life threateningly cold temperatures that winter storms can also bring. Potential winter storm impacts can be categorized using NOAA's Winter Storm Severity Index,[62] shown in the following table.

[62] Winter Storm Severity Index, NOAA, https://www.wpc.ncep.noaa.gov/wwd/wssi/wssi.php?id=FEMA10#

Table 2-9. Winter Storm Severity Index

Potential Winter Storm Impacts	
	Winter Weather Area **Expect Winter Weather.** • Winter driving conditions. **Drive carefully.**
	Minor Impacts **Expect a few inconveniences to daily life.** • Winter driving conditions. **Use caution while driving.**
	Moderate Impacts **Expect disruptions to daily life.** • Hazardous driving conditions. **Use extra caution while driving.** • Closures and disruptions to infrastructure may occur.
	Major Impacts **Expect considerable disruptions to daily life.** • Dangerous or impossible driving conditions. **Avoid travel if possible.** • Widespread closures and disruptions to infrastructure may occur.
	Extreme Impacts **Expect substantial disruptions to daily life.** • Extremely dangerous or impossible driving conditions. **Travel is not advised.** • Extensive and widespread closures and disruptions to infrastructure may occur. • Life-saving actions may be needed.

Information using this index for past winter storms impacting the Linn County is not available, however, details showing the range of impacts of some of the more recent winter storm events are included in the following history section.

History

Winter storms occur yearly; more destructive storms occur once or twice per decade, most recently in December 2015, February 2021, and January 2024. The following winter storms occurred within and/or near Linn County. Several winter storm events were added to this hazard history section since the previous plan (shown in *italics* below):[63]

- **Dec. 1861:** Statewide, Snowfall varied between 1 and 3 feet. Did not leave Willamette Valley floor until late February
- **Dec. 1864:** Willamette Valley and Columbia Basin, Heavy snowfall. Albany (Linn County) received 16 inches in 1 day.
- **Dec. 1884:** Columbia River Basin and Willamette Valley, Most of the heavy snow fell over the Columbia River Basin from Portland to The Dalles and along the Cascades foothills in the Willamette valley. Albany received 19 inches.
- **Dec. 1892:** Northwest Oregon, Substantial snow fell across most of northern Oregon, with the greatest snowfall reported over northwestern Oregon.
- **Jan. 1916**: Statewide, two snowstorms, each totaling 5 inches or more
- **Jan.- Feb. 1937:** Statewide, Heavy snow throughout the Willamette Valley. Corvallis received 18 inches of snow.

[63] Taylor, George H., and Ray Hatton, 1999, The Oregon Weather Book; The Spatial Hazard Events and Losses Database for the United States, [Online Database]. Columbia, SC: University of South Carolina. Available at http://www.sheldus.org; NOAA Storm Events Database, http://www.ncdc.noaa.gov/stormevents/

- **Jan. 1950:** Statewide, Heaviest snowfall since 1890. Many highway closures. Considerable property damage. Corvallis received 52 inches in snowfall for the month of January.
- **Jan. 1956:** Western Oregon, Packed snow became ice. Many automobile accidents throughout the region.
- **Mar. 1960:** Statewide, Snowfall: 3-12 inches, depending on location. More than 100 snow related accidents in Marion County.
- **Jan. 1969:** Statewide, for many areas, this was the most extreme storm on record. Snowfall over the state was much above normal, mostly in part due to a very cold January. Eugene had a total snow depth of 47 inches. Losses in livestock were heavy. Many communities were completely isolated for close to a week. At times, traffic on nearly every major highway west of the Cascades was halted. Three to $4 million in property damage statewide.
- **Jan. 1980:** Statewide, a series of storms bringing snow, ice, wind, and freezing rain. Six fatalities.
- **Feb. 1985:** Statewide, Western valleys received between 2-4 inches of snow; Massive power failures (tree limbs broke power lines)
- **Dec. 1985:** Willamette Valley, Heavy snowfall throughout valley
- **Mar. 1988:** Statewide, Strong winds and heavy snow
- **Feb. 1989:** Statewide, Heavy snowfall and record low temperatures. Salem received 9 inches. Extensive power failures as well as considerable home and business damage resulting from frozen plumbing throughout the state.
- **Feb. 1990:** Statewide, The Willamette Valley was coated with 2 to 4 inches except the higher hills around Portland received up to 1 foot.
- **Dec. 1992:** Western Oregon, Heavy snow. Interstate Highway closed.
- Feb. 1993: Western Oregon, Record snowfall at Salem airport.
- **Winter 1998-9:** Statewide, Series of storms. One of the snowiest winters in Oregon history.
- **Dec. 2003 – Jan. 2004:** Statewide, Wet snow blanketed highways in the Willamette Valley, causing power lines and trees to topple. Oregon 34 east of Philomath was closed for 30 hours January 5 and 6 while crews removed trees. Critical services were disrupted, 10,000 customers without power for 3 to 4 days; one person died as a result of power outage. Presidential disaster declaration for 30 of Oregon's 36 counties. (FEMA-1510-DR-OR)
- **Dec. 2008:** Willamette Valley, a series of storms dropped feet of snow over portions of the Willamette Valley. The onset of cold air moved in around December 14 and lingered through Christmas morning. (FEMA-1824-DR-OR)
- **Jan. – Feb. 2008:** A series of vigorous winter storms brought record setting snow accumulation to Detroit, Oregon. Three dozen Oregon National Guard personnel were called in to help with snow removal in Detroit and Idanha. The towns received over 12 feet of snow in several weeks.
- **Jan. 2012:** Severe winter storm, landslides, mudslides, flooding, including high winds. (FEMA-4055-DR-OR)
- **Mar. 2012:** mixture of snow, rain, wind throughout much of the coast and Willamette Valley, snow accumulations up to 7-inches, trees down, roads closed.
- **Dec. 2013:** Willamette Valley, snow accumulations up to 9-inches
- **Feb. 2014:** Coast and Willamette Valley, severe winter storm including high winds.

- ***Dec. 2015:*** *Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides. (FEMA-4258-DR-OR)*
- ***Jan. 7-8, 2017:*** *General snowfall totals of 2-4 inches were reported. Major ice accumulations occurred after the snow, with several locations reporting 0.50-1.00. The combination of snow and ice resulted in significant power outages and closures across the area.*
- ***Feb. 11-13, 2021****: In the Northern Cascade foothills, this event caused major problems as far south as Albany. Snow was followed by ice with significant impacts to infrastructure and over 400,000 people lost power at some point during the storm. (FEMA DR-4599)*
- ***Feb. 25, 2021****: This was a marginal but long-lived heavy snow event that eventually produced 10-20 inches of snow in the Cascades. Ski lifts were closed due to gusts 65-85 mph.*
- ***April 3, 2022****: A moderate atmospheric river event associated with a cold front across the region produced heavy snow in the Cascades.*
- ***April 10-11, 2022****: Unseasonably cold air was in place over the Pacific Northwest. This system brought several inches of snow to the Willamette Valley in addition to the Coast Range and Cascades. By the late morning/early afternoon, much of the snow west of the Columbia River Gorge had transitioned to rain. Farther north the system produced the latest snowfall in Portland ever recorded.*
- ***Dec. 22, 2022****: Most areas of the North Oregon Cascade foothills saw some combination of snow, sleet and freezing rain. The impact was mostly from ice.*
- ***Jan. 10-22, 2024:*** *A strong cold front swept across the Pacific Northwest on the 8th, ushering in much colder air. Many SNOTEL sites recorded 2 to 3 feet of snow, winds gusting to 78 mph at pass elevation resulting in hazardous driving conditions and the closure of ski lifts. Main highways such as Highway 26 were closed across the Cascades due to numerous crashes and spinouts.*

  A very strong arctic front moved across Western Washington and Oregon on the 12th and 13th dropping temperatures below freezing. With cold air in the lowlands, all precipitation fell as freezing rain for areas along the coast, valleys in the Coast Range, and Willamette Valley northward into southwest Washington. Interstate 5 was closed at MP 209 (Linn County) due to truck crashes. Consumer Power Incorporated, a private nonprofit utility, provides electrical power to 8,751 meters in Linn County, 2,895 (33.08%) of which were knocked out for up to two days. Damage costs were in Lane, Linn, and Benton counties. (FEMA DR-4768)

Probability Assessment

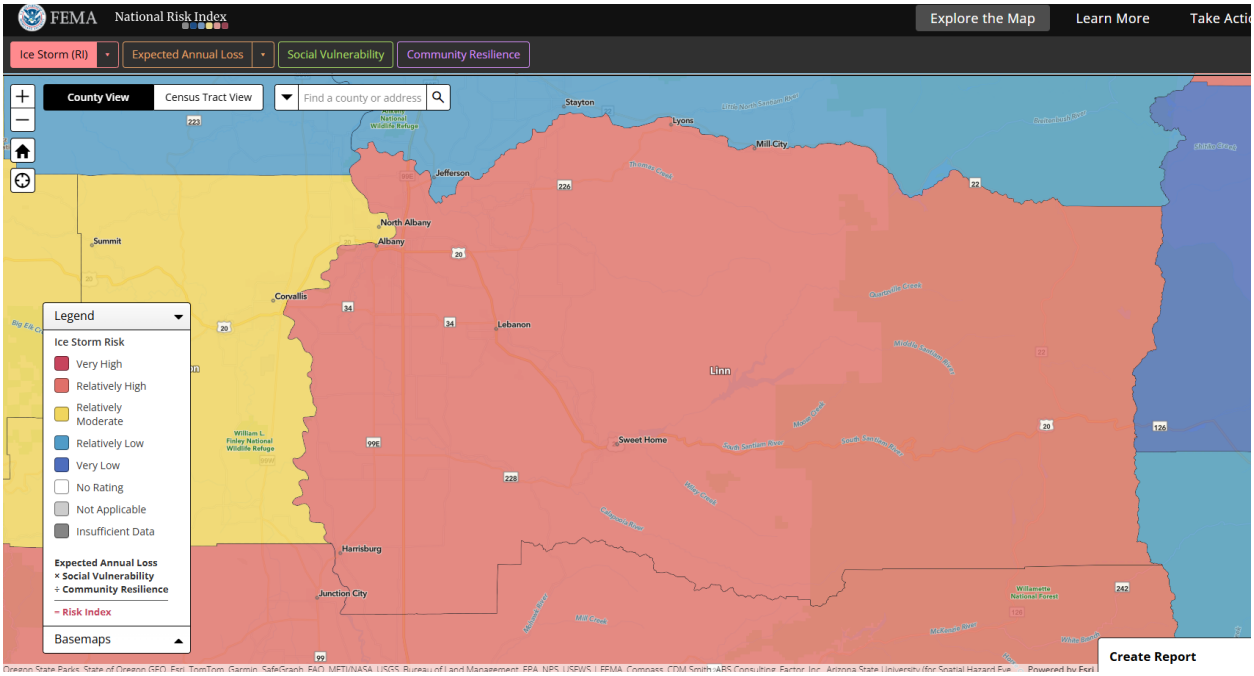
The recurrence interval for a severe winter storm is about every 13 years; however, there can be many localized storms between these periods. Severe winter storms occur in western Oregon regularly from November through February. Linn County experiences winter storms a couple times every year, particularly at higher elevations in the Cascades.

Based on participants' background and experience the NHMP Steering Committee determined the **probability of experiencing a winter storm or ice storm is "high,"** ranked at 9.0 out of 10 meaning one incident is likely within the next 10 to 35-year period. *This rating has not changed since the previous plan*.

Vulnerability and Impacts

Given current available data, no quantitative assessment of the risk of winter storm was possible at the time of this NHMP update to determine winter storm vulnerability in terms of explicit types and numbers of existing and future buildings, infrastructure, or critical infrastructure. However, FEMA's National Risk Index indicates that Linn County has a "Relatively High" risk from ice storm, as depicted in the following figure.

Figure 2-36. Ice Storm Risk for Linn County



Source: FEMA, National Risk Index, https://hazards.fema.gov/nri/map#

Additionally, assessing the risk to the County's people and assets from winter storms should remain an ongoing process determined by community characteristics and physical vulnerabilities. Linn County has added a new multi-hazard action item to evaluate vulnerability of and impacts to community assets from winter storms/ice storms where feasible. Weather forecasting can give County resources (emergency vehicles, warming shelters) time to prepare for an impending storm, but the changing character of the county population and resources will determine the impact of winter storms on life and property in Linn County.

The most likely impact of snow and ice events on Linn County are road closures limiting access/egress to/from some areas, especially roads to higher elevations or areas with limited access points. Severe winter weather also can cause the temporary closure of air and train operations, businesses, schools, government offices, and other important community services. Winter storms with heavy wet snow or high winds and ice storms may also result in power outages from downed transmission lines and/or poles. Below freezing temperatures can also lead to breaks in un-insulated water lines serving schools, businesses, industries, and individual homes.

Winter storms which bring snow, ice, and high winds can cause significant impacts to vulnerable individuals. Deaths can occur as a result of traffic accidents on icy roads, heart attacks may occur from exertion while shoveling snow, and hypothermia can result from prolonged exposure to

the cold. The temporary loss of home heating can be particularly hard on the elderly, young children, and other vulnerable individuals such as those who rely on medical equipment that requires electricity.

Property is at risk due to flooding and landslides that may result if there is heavy snowmelt. Additionally, ice, wind, and snow can affect the stability of trees, power and telephone lines, and TV and radio antennas. Downed trees and limbs can become major hazards for houses, cars, utilities, and other property. Such damage can also become a major obstacle to providing critical emergency response, police, fire, and other disaster response and recovery services.

All these effects, if lasting more than several days, can result in significant economic impacts for the affected communities and the surrounding region. In the rural areas of Oregon severe winter storms can isolate small communities, farms, and ranches.

Since much of the County's population resides in or close to the Cascades where severe winter storms often impact daily life, the NHMP Steering Committee rated the county as having a **"high" vulnerability to winter storm and ice storm hazards**, meaning that more than 10% of the region's population or assets would be affected by a major disaster. *This rating has not changed since the previous plan*.

More information on this hazard can be found in the Risk Assessment for Region 3, Mid-Willamette Valley of the Oregon NHMP (2020) and future updates.

Federal Disaster and Emergency Declarations

Reviewing past events can provide a general sense of the hazards that have caused significant damage in the county. Where trends emerge, disaster declarations can help inform hazard mitigation project priorities.

President Dwight D. Eisenhower approved the first federal disaster declaration in May 1953 following a tornado in Georgia. Since then, federally declared disasters have been approved within every state as a result of natural hazard related events. There are two types of disaster declarations provided for in the Stafford Act: Emergency declarations and Major Disaster declarations. Both declaration types authorize the President to provide supplemental federal disaster assistance. An Emergency Declaration is more limited in scope and without the long-term federal recovery programs of a Major Disaster Declaration. Generally, federal assistance and funding are provided to meet a specific emergency need or to help prevent a major disaster from occurring. The Fire Management Assistance declaration process is initiated when a state submits a request for assistance to FEMA at the time a "threat of major disaster" exists. This process happens on an expedited basis and a FEMA decision is rendered quickly. Through December 2024, 41 Major Disaster (DR) declarations, four Emergency (EM) declarations, and 108 Fire Management Assistance declarations (FM) have been approved for disasters in Oregon.[64]

When governors ask for presidential declarations of major disaster or emergency, they stipulate which counties in their state they want included in the declaration. Table 2-10 summarizes the federally declared disasters in Oregon that have affected Linn County since 1955. There have been 14 Major Disaster (DR) declarations for the county, including five since the previous plan.

[64] FEMA, Disasters and Other Declarations, https://www.fema.gov/disaster/declarations, Accessed January 6, 2025.

Except for the COVID-19 pandemic declaration, these were related to natural hazards, including wildfire and weather events resulting primarily in flooding, landslides, and wind related damage. Linn County has had three Emergency (EM) declarations, one related to the 2005 Hurricane Katrina evacuation, one related to COVID-19 pandemic in 2020, and one related to the 2020 wildfires. There have been two Fire Management Assistance (FM) declarations in the County, including one related to the 2020 wildfires.

Table 2-10. FEMA Major Disaster (DR), Emergency (EM), and Fire Management Assistance (FM) Declarations for Linn County

Declaration Number	Type of Incident	Incident Period
DR-4768	Sever Winter Storms, Straight-line Winds, Landslides, and Mudslides	January 10 - 22, 2024
DR-4599	Severe Winter Storm	February 11 - 15, 2021
DR-4562	Wildfires and Straight-line Winds	September 7 - November 3, 2020
EM-3542	Wildfires	September 8 - 15, 2020
FM-5356	Beachie Creek Lionshead Complex	September 7 – October 15, 2020
DR-4499 EM-3429	Covid-19 Pandemic	January 20, 2020 – May 11, 2023
DR-4452	Severe Storms, Flooding, Landslides and Mudslides	April 6 - 21, 2019
DR-4258	Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides	December 6 - 23, 2015
DR-4055	Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides	January 17 – 21, 2012
DR-1632	Severe Storms, Flooding, Landslides, and Mudslides	December 18, 2005 – January 21, 2006
EM-3228	Hurricane Katrina Evacuation	August 29 – October 1, 2005
DR-1510	Severe Winter Storm	December 26, 2003 – January 14, 2004
FM-2493	Booth Fire	August 20 – October 22, 2003
DR-1405	Severe Winter Windstorm with High Winds	February 7 - 8, 2002
DR-1099	Severe Storms/Flooding	February 4 – 21, 1996

Declaration Number	Type of Incident	Incident Period
DR-1107	Severe Storms/High Winds	December 10 – 12, 1995
EM-3039	Oregon Drought	1976 - 1977
DR-319	Severe Storms, Flooding	January 21, 1972
DR-184	Heavy rains and flooding	December 24, 1964

Source: FEMA, https://www.fema.gov/disaster/declarations

Vulnerability Summary

The vulnerabilities of community assets, including people, structures, natural systems, historic and cultural resources, and activities that have value, are an important component of the NHMP risk assessment. This section summarizes key vulnerabilities discussed in more depth in Appendix B: Community Profile as well as in each jurisdiction's addendum.

Population

The socio-demographic qualities of the community population such as language, race and ethnicity, age, income, and educational attainment are significant factors that can influence the community's ability to cope, adapt to and recover from natural disasters. Historically, 80 percent of the disaster burden falls on the public.[65] Of this number, a disproportionate burden is placed upon special needs groups, particularly children, the elderly, the disabled, minorities, and low-income persons. Population vulnerabilities can be reduced or eliminated with proper outreach and community mitigation planning.

Population Vulnerabilities

- Based on the U.S. Census Bureau, 2022 American Community Survey (ACS) 5-year estimates, cities in Linn County with higher than the county median age include Idanha, Lyons, Gates, Sodaville, Brownsville, and Waterloo. Scio, Millersburg, Sweet Home, and Tangent have median ages close to the county average, and Halsey, Harrisburg, Albany, Lebanon and Mill City have median ages below the county average. (See Table B-2 in Appendix B.)
- The Linn County age dependency ratio[66] is 71.3, which is higher than this statistic reported in 2016 (56.6). The old-age dependency ratio is highest in the cities of Gates and Lyons, meaning that there are respectively 54.9 and 45.1 individuals over the age of 64 per hundred working aged people in these cities. The child dependency ratio is highest in the cities of Millersburg and Harrisburg, meaning that there are 50.9 and 50.8 individuals under the age of 15 per hundred working aged people in these cities. (See Table B-3 in Appendix B.)

[65] Hazards Workshop Session Summary #16, *Disasters, Diversity, and Equity*, University of Colorado, Boulder (2000).
[66] Dependency Ratio: the ratio of population typically not in the work force (less than 15, greater than 64)

- Approximately 11.4% of Linn County population over age 64 lives alone; this percentage is greatest in Gates (16.5%) and Mill City (16.3%).
- Approximately 4.4% of households in Linn County are headed by single parents with children under 18. In the cities of Harrisburg (8.3%) Mill City (9.5%) and Sweet Home (8.8%) the percentage of single parent households has increased since 2016. All of these cities plus Sodaville (9.4%) have more than 8% of the total households headed by single parents. (See Table B-6 in Appendix B.)
- English proficiency may represent a vulnerability to understanding published information and alerts regarding natural hazards. Previously highlighted data regarding racial composition in the 2016 plan has been replaced with information about language proficiency. The cities of Albany, Lebanon, Tangent, and Mill City have between 4.9% and 2.8% of the population that speak English "less than very well." Lyons, Millersburg, Sodaville, Scio, and Waterloo have smaller portions of their populations who speak English "less than very well." (See Table B-4 in Appendix B.)
- Cities in Linn County with 2022 median income below the county average include Harrisburg, Lebanon, Sodaville, Tangent, and Sweet Home.
- Approximately 12% of the Linn County population (less than in 2016 at 19%) lived at or below the poverty line in 2022 (13.6% of children in 2022 down from 28% of children in 2015). Poverty for children has significantly worsened in Lyons moving from 15% to in 2015 to 39.2% in 2022. Also, poverty for children in Halsey more than doubled during that time period.
- While over 90% of the population older than 25 has graduated from high school or attained higher educational levels, just over 20% have a bachelor's degree or higher. Sodaville and Scio have the lowest percentage of people with a bachelor's degree or higher at 9.3% and 8.6% respectively, while 30.9% of people in Millersburg have attained this educational level.
- Approximately 18% of the Linn County population is estimated to have a disability. Of that, approximately 9,159 individuals over 65 or older (38%) are disabled.

Economy

Economic diversification, employment, and industry are measures of economic capacity. However, economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how the component parts of employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture. The current and anticipated financial conditions of a community are strong determinants of community resilience, because a strong and diverse economic base increases the ability of individuals, families, and the community to absorb disaster impacts for a quick recovery.

Economic Strengths and Vulnerabilities

Among the strengths is that job growth in Linn County is outpacing job loss, and wages are competitive. In particular from 2020 t0 2021 there was a very high increase in mean annual earnings for Fire Fighting & Prevention and other Protective Service Workers. Wages in this sector rose 53.6% from 2020–2021, however the size of the workforce in this sector shrank by 17.8% during the same period.

Another feature of the Linn County economy is that jobs are concentrated in specialized trades such as construction, wood product manufacturing, and primary metal manufacturing industries and depend on local, skilled labor. Projected population growth supports a growing local economy.[67]

Among the signals of less resilience within the Linn County economic profile is Linn County's older and less educated workforce as compared to the State of Oregon averages. This indicates some economic resilience risks related to employment diversity and earned wages. The number of people employed in the Personal Care & Service professions also shrank and the wages decreased by 21.8% from 2020-2021.

Another point of vulnerability lies within the construction sector. The number of people employed in the Construction & Extraction Industry increased by 6.14%, however earnings decreased by 54.8% during this period.[68]

The agriculture and forestry sectors are vulnerable to drought, extreme heat, and wildfire, which can directly impact the natural resources that these industries are dependent upon, further discussed below. These sectors are also vulnerable as their workforce is primarily outdoor, thus more susceptible to impacts from smoke and poor air quality.

For additional details see Appendix B: Community Profile.

Environment

The capacity of the natural environment is essential in sustaining all forms of life including human life, yet it is often underrepresented in evaluating community resilience to natural hazards. The natural environment includes land, air, water, and other natural resources that support and provide space to live, work, and recreate.[69] Ecosystems, such as wetlands and forested hill slopes, play significant roles in protecting communities and the environment from weather-related hazards, such as flooding and landslides. When human activities impact or deplete natural systems, they also adversely affect community resilience to natural hazard events.

Environmental Vulnerabilities

The principal vulnerability associated with the natural environment is that forest ecosystems are vulnerable to drought, wildfire, and severe storm impacts. Forest ecosystems, both federal-, state- and privately-owned, support the logging industry. Although this industry is a less prominent part of the local economy than it once was, it is a core industry for Linn County. Wood product manufacturing wages are among the fastest growing in Linn County.

For additional details see Appendix B: Community Profile.

[67] University of Oregon, Institute for Policy Research and Engagement, Linn County Economic Resilience Profile.
[68] Linn County, OR | Data USA, https://datausa.io/profile/geo/linn-county-or.
[69] Mayunga, J. "Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. Summer Academy for Social Vulnerability and Resilience Building," (2007).

Built Environment, Critical Facilities, and Infrastructure

Critical facilities (i.e. police, fire, and government facilities), housing supply, and physical infrastructure are vital during a disaster and are essential for proper functioning and response. The lack or poor condition of infrastructure can negatively affect a community's ability to cope, respond, and recover from a natural disaster. Following a disaster, communities may experience isolation from surrounding cities and counties due to infrastructure failure. These conditions force communities to rely on local and immediately available resources.

Housing Vulnerabilities

Housing Type: Mobile home and other non-permanent residential structures account for almost 15% of housing in Linn County. In Tangent, Waterloo, and Sodaville mobile homes account for 42% - 38% of housing units. These structures are particularly vulnerable to certain natural hazards, such as earthquake, windstorms, and heavy flooding events.

Age of Housing: Based on U.S. Census data, approximately 62% of the residential housing in Linn County was built before the current seismic building standards of the early 1990s. Approximately 40% of residential structures were constructed prior to the local implementation of the flood elevation requirements of the 1970's (county Flood Insurance Rate Maps –FIRMs- were not completed until the late 1970s and early 1980s).

For additional details see Appendix B: Community Profile and Volume II: City and District Addenda.

Critical Facilities and Infrastructure Vulnerabilities

Transportation: Virtually all state and county roads and bridges in Linn County are vulnerable to multiple hazards including flood, landslides, and earthquake. Impacts to the transportation system can result in the isolation of vulnerable populations, limit access to critical facilities such as hospitals, and adversely impact local commerce, employment, and economic activity.

Energy: Most of Linn County's power is generated outside the region; there is no redundancy in power transmission and only limited redundancy in the power distribution network.

Dams: There are seven dams in Linn County that are categorized as High Hazard. Six of these are federally regulated dams and the other is regulated by the state. More information regarding dams and dam safety is included above in the Dam Failure section of this risk assessment and in Appendix B: Community Profile.

For additional details see Appendix B: Community Profile and Volume II: City and District Addenda.

Historic and Cultural Resources

Historic and cultural resources and important cultural events can help to define a community and may also be sources of community identity. Protecting these resources and activities from the impact of disasters is important because they have an important role in connecting people to their community and to each other. Linn County participates in the Certified Local Government (CLG) program, which is designed to promote historic preservation at the local

level. The CLG program is a program of the National Park Service administered by Oregon's State Historic Preservation Office (SHPO). Linn County and the several of the cities have lists of historical properties identified as irreplaceable and that merit preservation. Overall, there are a total of 1,858 historically registered places in Linn County. Some of the cities use zoning overlays that further protect these resources. In other communities, there are structures and buildings that are considered valuable cultural resources that are not officially listed, along with important cultural events.

Historical and Cultural Resources Vulnerabilities

Historic and cultural resources are vulnerable to natural hazards, including buildings, structures, historic districts, artifacts, collections, access to sacred sites, and community events. These resources are not only intrinsically valuable but also play a critical role in community identity, shared experience, and recovery after disasters.[70] In Linn County, these resources are particularly vulnerable to earthquake, flooding, and wildfire due to age, building materials, lack of maintenance and condition, and location. For listed historic properties, improvements to increase resilience require a balanced approach that considers preservation of the historic integrity of the building. Community and cultural events are also vulnerable to natural hazards, including smoke and poor air quality that are increasingly impacting outdoor events, leading to cancellation, which in turn reduces opportunities for community gathering and celebration as well as causing economic impacts to event organizers and vendors, among others.

See Appendix B: Community Profile and Volume II: City and District Addenda for more information about specific historical and cultural resources.

National Flood Insurance Program and Floodplain Ordinance Requirements

The National Flood Insurance Program (NFIP) provides insurance to help reduce the socio-economic impact of floods. The NFIP is managed by FEMA and provides flood insurance to participating property owners, renters, and businesses. Having this coverage helps them recover faster when floodwaters recede. The NFIP is voluntary, with participating communities required to adopt and enforce floodplain management regulations that help mitigate flooding effects. FEMA modernized the Linn County Flood Insurance Rate Maps (FIRMs) in September 2010.

NFIP Vulnerabilities

Table 2-11, below, shows that based on information from the State of Oregon NFIP Coordinator and the FEMA Region X Regional Flood Insurance Liaison, Linn County and NFIP participating cities have 437 NFIP policies in force. The City of Sodaville is a non-participating community as there is no mapped special flood hazard area in the city limits. The cities of Gates and Halsey participate in the NFIP, but there are no NFIP policies in force in those communities.

The last Community Assistance Visit (CAV) for unincorporated Linn County was on June 26, 2019. The cities of Halsey and Lyons have not received Community Assistance Visits or

[70] Oregon Parks and Recreation, Disaster Preparedness, Recovery & Resilience, https://www.oregon.gov/oprd/oh/pages/disasterprep.aspx

Community Assistance Contacts since the mid-1990's. The cities of Albany and Scio participate in the Community Rating System (CRS) and have ratings of 6 and 10 respectively. Data provided in the 2016 NHMP showed that the majority of flood insurance policies are for residential structures, primarily single-family homes.

To date there have been 121 paid claims in the county totaling just over $1.65 million. In addition, there have been four substantial damage claims paid to date. Linn County has six Repetitive Loss properties.[71] The Repetitive Loss properties are single-family residential, per Linn County, which also provides building permit inspection services for Scio.

Table 2-11. NFIP Flood Insurance Details

Jurisdiction	Effective FIRM & FIS	Total Policies	Insurance in Force	Substan-tial Damage Claims	No. Paid Losses	Total Losses Paid	Repetitive Loss Properties	CRS Community	Last Community Assistance Visit	Last Community Assistance Contact
Unincorporated	12/8/2016	302	$73,072,000	3	82	$1,014,109	5		6/26/2019	-
Brownsville	9/29/2010	24	$6,006,000	0	5	$41,985	0		7/27/2005	-
Gates	12/8/2016	0	$0	0	0	$0	0		-	6/28/2021
Halsey	9/29/2010	0	$0	0	0	$0	0		-	2/25/1993
Harrisburg	9/29/2010	7	$2,431,000	0	0	$0	0		6/20/2019	12/2/1992
Lebanon	9/29/2010	18	$5,350,000	0	0	$0	0		6/4/2019	12/14/2011
Lyons	9/29/2010	2	$600,000	0	0	$0	0		3/31/1995	-
Millersburg	12/8/2016	15	$4,272,000	0	0	$0	0		1/1/1992	5/7/2020
Scio	9/29/2010	49	$13,583,000	1	30	$589,440	1	Yes	10/10/2018	-
Sweet Home	9/29/2010	11	$2,119,000	0	3	$7,877	0		6/27/2019	-
Tangent	9/29/2010	9	$2,548,000	0	1	$2,635	0		6/18/2019	-
Waterloo	9/29/2010	0	$0	0	0	$0	0		-	-

Source: Information compiled by Department of Land Conservation and Development, July 2024, and FEMA Region X, September 2024.

The locations and types of flood hazard zones that are present are illustrated in the special flood hazard area map in each city's addendum (see Volume II) and shown countywide in Figure 2-13, included in the above flood hazard section of this risk assessment.

NFIP and Floodplain Ordinance Requirements

Linn County manages floodplain development through its flood management code.[72] The Planning and Building Department is the lead for implementing NFIP requirements and application of the flood management code. Each of the cities participating in the Linn County MJNHMP also have adopted flood management codes, referenced in their respective

[71] A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling ten-year period, since 1978. A RL property may or may not be currently insured by the NFIP.

[72] Linn County Flood Management Code, Chapter 870 of Title 8, Building Code; https://www.linncountyor.gov/media/26726

addendums. These floodplain development codes meet FEMA and state standards and are based on the Oregon Model Flood Hazard Ordinance,[73] developed in cooperation with FEMA to help communities achieve compliance with the minimum NFIP and state standards for floodplain management, approved by FEMA in 2019.

In addition to the minimum requirements, FEMA and DLCD encourage local governments to adopt higher standards that make sense for each community and their unique flood risk, and some of Linn County's floodplain standards are higher than the minimum FEMA requirements. The adoption and implementation of local floodplain regulations that meet the minimum NFIP requirements is recognized by the State of Oregon as compliance with Statewide Planning Goal 7: Areas Subject to Natural Hazards for coastal and riverine flood hazards; more information about Oregon's Statewide Land Use Planning Program and Goal 7 is included in Appendix B: Community Profile.

The County's Planning Manager administers the County's floodplain management program and is a Certified Floodplain Manager trained in NFIP policies and federal, state, and local floodplain regulations. Each city, except for Sodaville which does not participate in the NFIP, maintains a floodplain manager role filled by a range of staff including community development, planning, and city management, depending on the size of the city. The floodplain manager in each jurisdiction is responsible for the implementation and enforcement of local floodplain regulations, including applying substantial damage and substantial improvement regulations as required by their adopted FEMA compliant floodplain ordinances. Linn County provides building permit inspection services for some of the smaller cities, including Scio, Brownsville, Millersburg, Mill City, Lyons, Tangent, Halsey, Sodaville, and Waterloo. The cities of Sweet Home and Lebanon manage their own building inspection program, and Harrisburg's building inspection program is run by the city of Junction City, located in Lane County. The city of Gates' building permit inspection program is run by Marion County.

Risk Assessment

Multi-jurisdictional Risk Assessment - §201.6(c) (2) (iii): For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

One method of assessing risk was provided by DOGAMI whose analyst estimated losses and analyzed exposure to geologic and wildfire hazards using a modeling approach.

For a more locally informed perspective, the Linn County Steering Committee worked with the DLCD project manager to develop a county-wide risk assessment. Representatives from the participating cities and district joined with the county representatives to assess four factors based on their personal background and experience.

Additionally, the Steering Committee conducted a community survey to gather information which informed the risk assessment.

[73] Oregon Model Flood Hazard Ordinance; https://www.oregon.gov/lcd/NH/Documents/DLCD_Final_FEMA_Approved_OregonModelFloodHazardOrdinance_10232020.pdf

Loss Estimation and Exposure Assessment

DOGAMI's Multi-Hazard Risk Report for Linn County comprises much of this risk assessment. It includes a countywide building inventory developed from building footprint data, Linn County's tax assessor database, and a suite of datasets representing the best science for a variety of natural hazards. The results of the DOGAMI risk report are integrated throughout this section, above, and the full report is included as Appendix E of this Plan.

Depending on the natural hazard, either losses were estimated, or exposure was assessed; both were performed for the flood hazard. Loss estimation was modeled using Hazus-MH,[74] a tool developed by FEMA for calculating damage to buildings from flood and earthquake. Loss estimates identify buildings in hazard areas and apply damage functions based on the hazard severity and building characteristics. Loss estimation is reported as a percentage of estimated loss relative to the total replacement value of a building. Loss estimation was performed for a CSZ Magnitude 9.0 earthquake, a crustal earthquake scenario on the Turner and Mill Creek fault at 6.6 Mw, and a 1% or 100-year flood scenario.

Exposure is a determination of the number of buildings, building value, and people within a hazard zone. Population was determined by associating 2020 census data with residential buildings. Exposure is reported as the total value of buildings within a hazard zone and the number of potentially displaced residents. Exposure was assessed for landslides, channel migration, lahar, and wildfire.

Local Risk Assessment

For local governments, conducting the hazard analysis is a useful step in planning for hazard mitigation, response, and recovery. The method provides the jurisdiction with a sense of hazard priorities but does not predict the occurrence of a particular hazard.

The DLCD project manager used a modified version of the OEM-FEMA Local Risk Assessment Methodology, described below, to guide the Steering Committee in assessment of factors that comprise the OEM Local Risk Assessment Methodology - History, Probability, Vulnerability, and the Maximum Threat. The Community Profile in this Plan provides factual evidence for the discussion of vulnerability. The OCCRI Future Climate Projections report for Linn County informs the assessment of probability for some hazards and the background and experience of the participants is reflected in the rankings, included as Appendix F of this Plan.

The Steering Committee also discussed how to address specific vulnerabilities within some county populations, infrastructure, critical facilities, and other assets. They specifically identified the vulnerability of people who make their living from ranching, farming, and forestry in Linn County to the natural hazards of drought, flood, and wildfire. Low-income families and those in substandard housing may be at risk of impacts of flood or extreme heat. The road system, some critical facilities, and some transportation water and wastewater infrastructure are at risk from an earthquake. The electric power transmission system that serves all the county residents and may be relied on by people who rely on power for health equipment may be at particular risk

[74] https://www.fema.gov/hazus-software

from windstorms and winter storms. The mitigation strategy actions developed to address many of these hazards provide additional detail.

Local assessment of relative hazard risk was accomplished using a methodology developed by FEMA and refined by OEM. It is called the “Local Risk Assessment Methodology” or “OEM Methodology” in this Plan. This methodology produces scores that range from 24 to 240. Vulnerability and Probability are the two key components. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. The weighting of the four factors results in Vulnerability accounting for approximately 60% of the total score, and Probability approximately 40%.

In this analysis, severity ratings, and weight factors, are applied to the four categories of history, probability, vulnerability, and maximum threat (worst-case scenario) as described below.

History (Weight Factor = 2)

History is the record of previous occurrences. Events to include in assessing the history of a hazard in a jurisdiction are events for which the following types of activities were required:

- The Emergency Operations Center (EOC) or alternate EOC was activated;
- Three or more Emergency Operations Planning (EOP) functions were implemented, e.g., alert & warning, evacuation, shelter, etc.;
- An extraordinary multi-jurisdictional response was required; and/or
- A "Local Emergency" was declared.

LOW = 0 to 1 event in the past 100 years, scores between 1 and 3 points
MODERATE = 2 to 3 events in the past 100 years, scores between 4 and 7 points
HIGH = 4+ events in the past 100 years, scores between 8 and 10 points

Probability (Weight Factor = 7)

Probability is the likelihood of future occurrence within a specified period of time.

LOW = one incident likely within 75 to 100 years, scores between 1 and 3 points
MODERATE = one incident likely within 35 to 75 years, scores between 4 and 7 points
HIGH = one incident likely within 10 to 35 years, scores between 8 and 10 points

Vulnerability (Weight Factor = 5)

Vulnerability is the percentage of population and property likely to be affected under an “average” occurrence of the hazard.

LOW = < 1% affected, scores between 1 and 3 points
MODERATE = 1 - 10% affected, scores between 4 and 7 points
HIGH = > 10% affected, scores between 8 and 10 points

Maximum Threat (Weight Factor =10)

Maximum threat is the highest percentage of population and property that could be impacted under a worst-case scenario.

LOW = < 5% affected, scores between 1 and 3 points
MODERATE = 5 - 25% affected, scores between 4 and 7 points
HIGH = > 25% affected, scores between 8 and 10 points

Conducting this analysis individually using an online questionnaire and then discussing it as a group was a useful early step in soliciting ideas for improvements to the strategy for hazard mitigation, response, and recovery. Common themes of vulnerability and the mitigation strategies undertaken since the 2017 update were topics discussed among the Steering Committee members during the discussion of the ranking process.

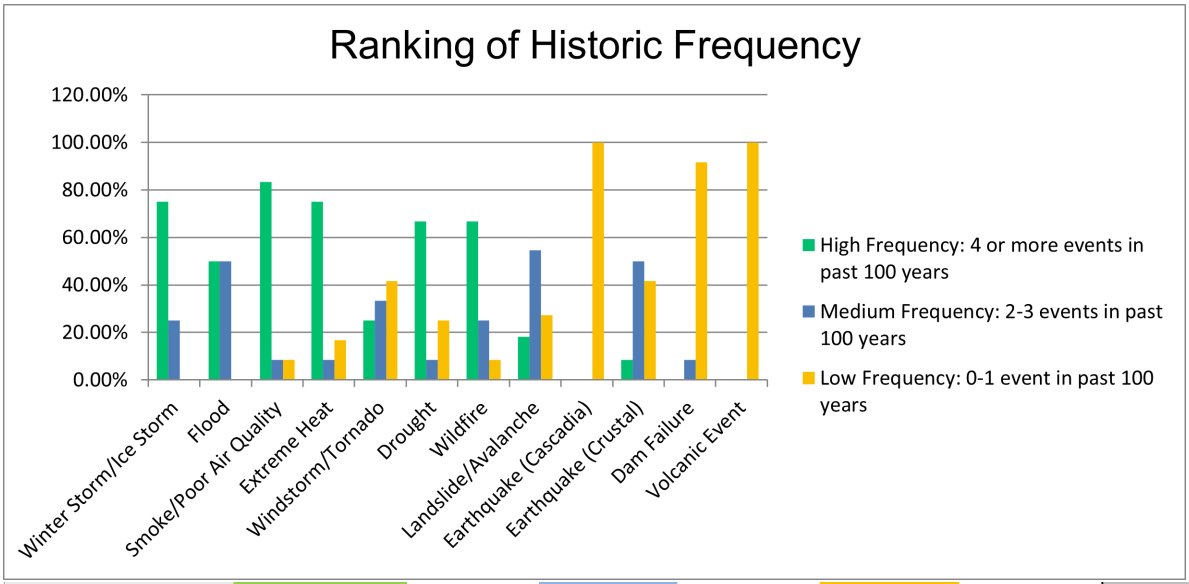
The Steering Committee conducted the OEM Methodology ranking exercise with the use of an online polling tool, Survey Monkey, which allowed respondents to rank the list of hazards for each of the four factors for each of the thirteen identified natural hazards. The average ranking of each natural hazard was converted into a score using the rubric detailed above.

At the first meeting focused on risk assessment, the DLCD project manager conducted a discussion of what natural hazards pose a significant threat to the residents of Linn County. The Steering Committee members identified three new natural hazards to address in this NHMP: Smoke and Poor Air Quality, Extreme Heat, and Dam Failure. At this introductory meeting, the project manager demonstrated the ranking survey. Following the meeting, the survey link was provided to the Steering Committee members to conduct individual rankings. The average ranking of all individual participants' responses was converted into the total risk score shown in the tables below.

For example, nine participants ranked Winter Storm/Ice Storm as a High Historic frequency, three participants ranked this hazard as a Medium Historic frequency, and no participants ranked this hazard as a Low Historic frequency hazard. The median score for each level was multiplied by the number of participants who ranked the hazard at each level. High was scored as 9; Medium was scored as 5.5, and Low was scored as 2. The severity score was arrived at by multiplying the number of responses by the score, adding the sub scores, and dividing by the total number of rankings. For Historic frequency of Winter Storm/Ice Storm the calculation was [(9 x 9) + (3 x 5.5) +(0 x 2)]/12 = 8.1

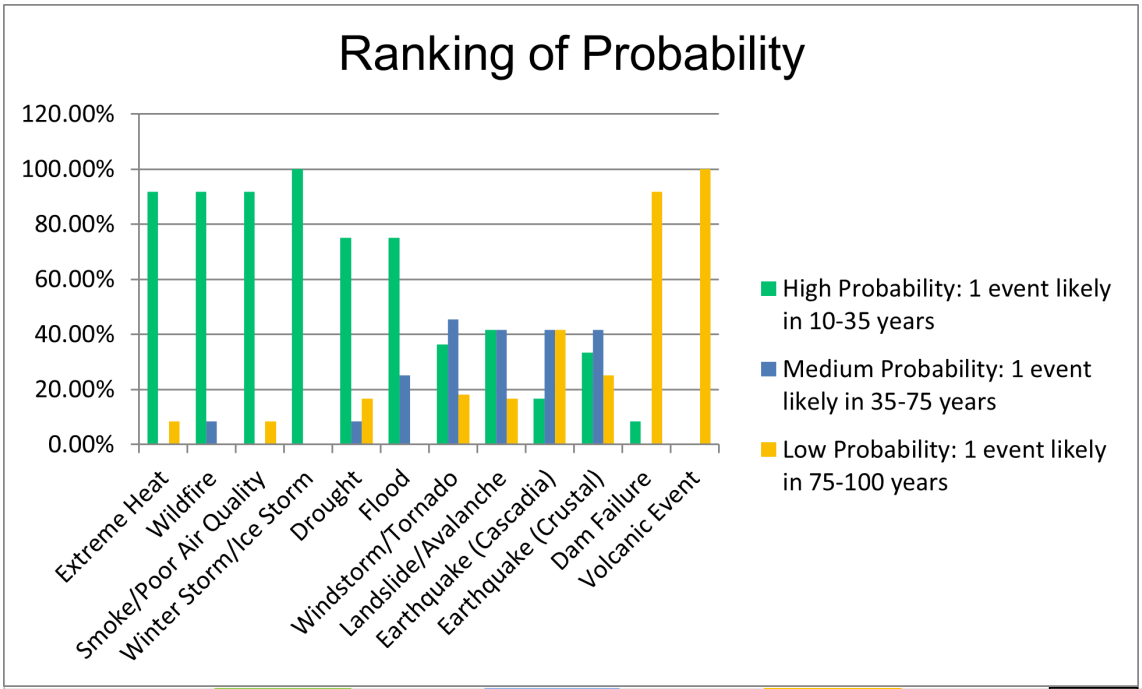
Using this method the OEM Methodology was completed without excessive time spent and allowing each participant an equal opportunity to provide rankings. The following figures show the results of the survey and associated rankings.

Figure 2-37. Ranking Historic Frequency



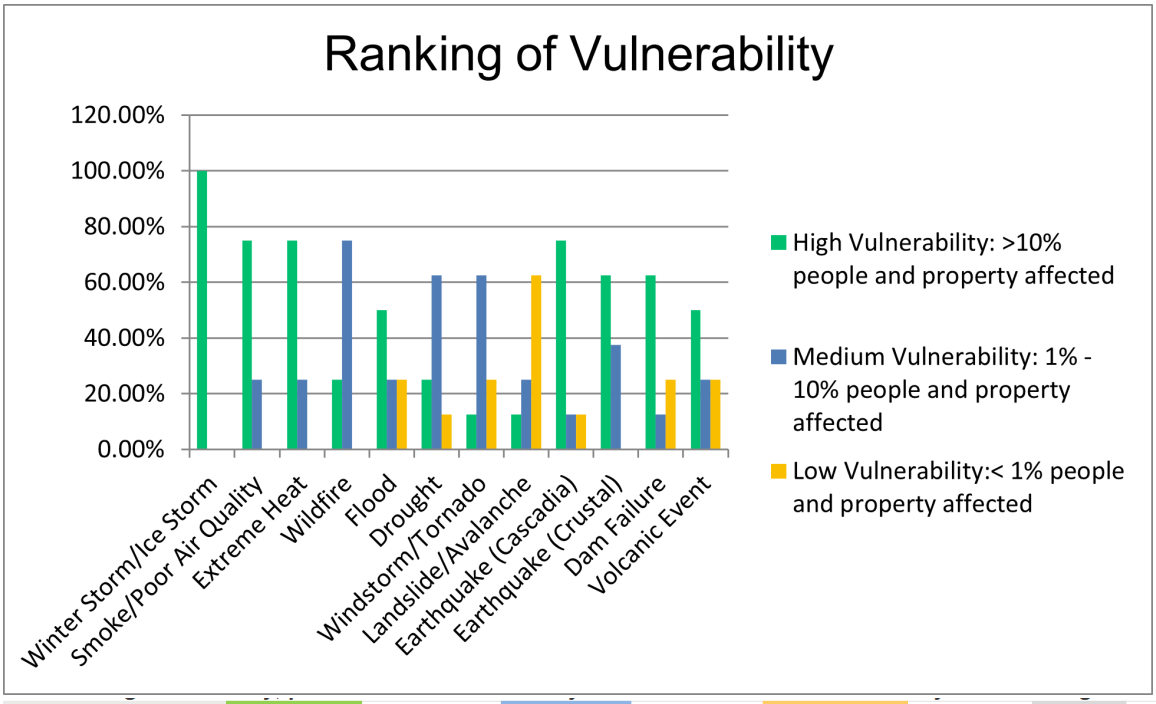
	High Frequency: 4 or more events in past 100 years	Avg Score	Medium Frequency: 2-3 events in past 100 years	Avg Score	Low Frequency: 0-1 event in past 100 years	Avg score	Severity score
Winter Storm/Ice Storm	9	9	3	5.5	0	2	8.1
Flood	6	9	6	5.5	0	2	7.3
Smoke/Poor Air Quality	10	9	1	5.5	1	2	8.1
Extreme Heat	9	9	1	5.5	2	2	7.5
Windstorm/Tornado	3	9	4	5.5	5	2	4.9
Drought	8	9	1	5.5	3	2	7.0
Wildfire	8	9	3	5.5	1	2	7.5
Landslide/Avalanche	2	9	6	5.5	3	2	4.8
Earthquake (Cascadia)	0	9	0	5.5	12	2	2.0
Earthquake (Crustal)	1	9	6	5.5	5	2	4.3
Dam Failure	0	9	1	5.5	11	2	2.3
Volcanic Event	0	9	0	5.5	12	2	2.0

Figure 2-38. Ranking Probability



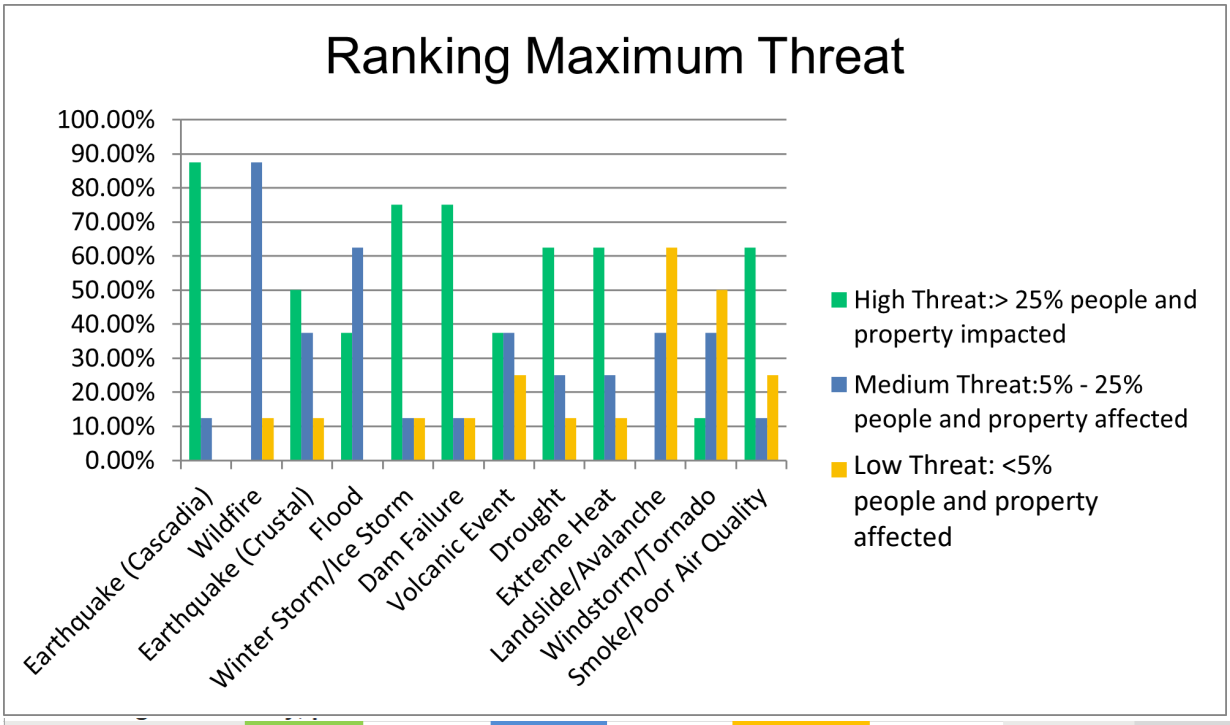
	High Probability: 1 event likely in 10-35 years	Avg Score	Medium Probability: 1 event likely in 35-75 years	Avg score	Low Probability: 1 event likely in 75-100 years	Avg Score	Severity Score
Extreme Heat	11.0	9.0	0.0	5.5	1.0	2.0	8.4
Wildfire	11.0	9.0	1.0	5.5	0.0	2.0	8.7
Smoke/Poor Air Quality	11.0	9.0	0.0	5.5	1.0	2.0	8.4
Winter Storm/Ice Storm	12.0	9.0	0.0	5.5	0.0	2.0	9.0
Drought	9.0	9.0	1.0	5.5	2.0	2.0	7.5
Flood	9.0	9.0	3.0	5.5	0.0	2.0	8.1
Windstorm/Tornado	4.0	9.0	5.0	5.5	2.0	2.0	5.6
Landslide/Avalanche	5.0	9.0	5.0	5.5	2.0	2.0	6.4
Earthquake (Cascadia)	2.0	9.0	5.0	5.5	5.0	2.0	4.6
Earthquake (Crustal)	4.0	9.0	5.0	5.5	3.0	2.0	5.8
Dam Failure	1.0	9.0	0.0	5.5	11.0	2.0	2.6
Volcanic Event	0.0	9.0	0.0	5.5	12.0	2.0	2.0

Figure 2-39. Ranking Vulnerability



	>10% people ar		% - 10% peopl		< 1% people and		Severity Score
Winter Storm/Ice Storm	8	9	0	5.5	0	2	9.0
Smoke/Poor Air Quality	6	9	2	5.5	0	2	8.1
Extreme Heat	6	9	2	5.5	0	2	8.1
Wildfire	2	9	6	5.5	0	2	6.4
Flood	4	9	2	5.5	2	2	6.4
Drought	2	9	5	5.5	1	2	5.9
Windstorm/Tornado	1	9	5	5.5	2	2	5.1
Landslide/Avalanche	1	9	2	5.5	5	2	3.8
Earthquake (Cascadia)	6	9	1	5.5	1	2	7.7
Earthquake (Crustal)	5	9	3	5.5	0	2	7.7
Dam Failure	5	9	1	5.5	2	2	6.8
Volcanic Event	4	9	2	5.5	2	2	6.4

Figure 2-40. Ranking Maximum Threat



	High Threat:> 25% people and property impacted		Medium Threat:5% - 25% people and property affected		Low Threat >%5 people and property affected		Total	Severity Score
Earthquake (Cascadia)	7	9	1	5.5	0	2	8	8.6
Wildfire	0	9	7	5.5	1	2	8	5.1
Earthquake (Crustal)	4	9	3	5.5	1	2	8	6.8
Flood	3	9	5	5.5	0	2	8	6.8
Winter Storm/Ice Storm	6	9	1	5.5	1	2	8	7.7
Dam Failure	6	9	1	5.5	1	2	8	7.7
Volcanic Event	3	9	3	5.5	2	2	8	5.9
Drought	5	9	2	5.5	1	2	8	7.3
Extreme Heat	5	9	2	5.5	1	2	8	7.3
Landslide/Avalanche	0	9	3	5.5	5	2	8	3.3
Windstorm/Tornado	1	9	3	5.5	4	2	8	4.2
Smoke/Poor Air Quality	5	9	1	5.5	2	2	8	6.8

The OEM Methodology does not predict the occurrence of a particular hazard, but it does "quantify" the relative risk of one hazard compared with another. The results of the OEM Methodology are also location dependent. During individual jurisdiction and district interviews with the DLCD project manager, the representatives of the participating jurisdictions and districts differentiated between the relative importance of these natural hazards in their localities as compared to the rankings for the county as a whole. The details of these specific adjustments for each city are provided in the Addenda.

Table 2-12, below, presents the entire updated hazard analysis matrix for Linn County. The hazards are listed in rank order from high to low. The table shows that hazard scores are influenced by each of the four categories combined, with considerations for past historical events, the probability or likelihood of a particular hazard event occurring, the vulnerability to the community, *and* the maximum threat or worst-case scenario. The top hazard threats to the county (top tier) include Winter Storm/Ice Storm, Extreme Heat, and Smoke and Poor Air Quality. Flood, Drought, Earthquake (Cascadia), Wildfire, and Earthquake (crustal) events rank in the middle (middle tier). Dam Failure, Windstorm/Tornado, Volcano (volcanic ash and lahar), and Landslide/Avalanche comprise the lowest ranked hazards in the county (bottom tier).

Table 2-12. Linn County Local Risk Assessment

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

NHMP Community Survey

The Steering Committee conducted a community survey between August 5, 2024, and October 31, 2024. 74 people responded to the survey. The survey was intended to gather information and feedback from community members to help county, city, and district leaders better understand how people have been impacted by natural hazards, to hear their highest concerns, and to identify strategies to help reduce that risk. The results informed the Steering

Committee's update of the Plan's risk assessment and mitigation strategy. Survey highlights include the following:

- Respondents live in a variety of urban and rural areas of Linn County.
- More than 50% of the respondents have been affected by power outages, followed by roads being blocked (34%), then property damage (30%). Two respondents from Lyons shared that they lost everything they have, while 24% of people noted they have never been impacted by a natural hazard event.
- The top four hazards of most concern were Wildfire (71%), followed by Winter Storms/Ice Storms (47%), Smoke and Poor Air Quality (42%), and Excessive Heat (36%).
- Landslide and Avalanche hazards were at the lower end of concern (86%) as were Volcanic eruptions (78%).
- The top three ways that residents receive information about how to protect their household and property from damage due to natural disaster include Linn-Benton ALERT (43% Always and 33% Sometimes), Community-run Facebook groups (25% Always and 41% Sometimes), and City or county social media (10% Always and 55% Sometimes). City or county website (5% Always and 35% Sometimes) and My child's school (6% Always and 38% Sometimes) were also noted.
- On the other end of the scale, respondents noted they never use the following means to receive information about natural disasters: Fact sheet/brochures (48%), Local newspapers (51%), Extension service (57%), and Workshops/meetings (60%).
- Respondents shared additional ways they receive information about how to protect from natural disasters, including email, text, 211info sharing, NOAA app, other social media (YouTube and Instagram), and word of mouth, among others.
- In response to the question about how people feel their community is doing to make people aware of the natural hazards they may face, the results were Fair (48%), Good (30%), Poor (18%), and Excellent (4%).
- 49% of respondents have an emergency kit, while 26% are working on it, and the remaining 25% do not have one.
- The barriers to getting an emergency kit included Cost (54%), Not sure what to put in it (30%), time (10%), and Don't see a need (7%). No one selected "Someone else will help me in an emergency."
- 52% of respondents have an emergency plan, 20% do not, and 27% are working on it.
- Barriers to making an emergency plan include I'm not sure how to make a plan (60%), Someone else will help me if there is a need (15%), Don't see a need (15%), and No interest (9%).
- The final survey question included questions and comments about the plan.

The survey questions and full results are included in Appendix A: Planning and Public Process.

SECTION 3: MITIGATION STRATEGY

Section 3 outlines Linn County's strategy to reduce or avoid long-term vulnerabilities to the identified hazards. Specifically, this section includes a mission and specific goals and actions thereby addressing the mitigation strategy requirements contained in 44 CFR 201.6(c). The NHMP Steering Committee reviewed and updated the mission, goals, and action items documented in this plan. Additional planning process documentation is in Appendix A.

Mitigation Plan Mission

The mission states the purpose and defines the primary functions of Linn County's NHMP. It is intended to be adaptable to any future changes made to the Plan and need not change unless the community's environment or priorities change.

The **mission** of the Linn County NHMP is:

> ***To reduce the impact of natural hazards on the community through planning, communication, coordination, and partnership development.***

The 2023-2025 NHMP Steering Committee reviewed the 2017 plan's mission statement and agreed it still accurately captured the mission of Linn County's MJ-NHMP.

Mitigation Plan Goals

Mitigation plan goals are more specific statements of direction that Linn County residents, businesses, and public and private partners can consider while working to reduce the risk from natural hazards in Linn County. These statements of direction form a bridge between the broad mission statement and particular action items. The goals serve as checkpoints as agencies and organizations begin implementing mitigation action items.

All of the **Plan goals** are important and are listed below in no particular order of priority:

> **Goal 1:** *Enhance coordination and communication among Linn County stakeholders to implement the Plan.*
>
> **Goal 2:** *Protect life, the built environment, and natural systems through County policies, procedures, and services.*
>
> **Goal 3:** *Protect life, the built environment, the economy, and natural resources through community-wide partnerships.*

Establishing community priorities within action items neither negates nor eliminates any goals, but it establishes which action items to consider implementing first should funding become available.

Stakeholder and community participation was a key aspect in developing the plan goals. Meetings with the project Steering Committee and the Linn County staff served as methods to

obtain input and understand priorities among goals for reducing risk and preventing loss from natural hazards in Linn County.

The 2023-2025 Linn County MJ-NHMP Steering Committee reviewed and discussed the 2017 plan goals in comparison to the State Natural Hazard Mitigation Plan (2020) goals. The Steering Committee determined that the 2017 NHMP goals still accurately encompassed the range of activities the County and jurisdictions would like to pursue to mitigate the potential damage caused by natural hazards and agreed to adopt the goal statements as previously composed. The goals presented here, therefore, are the same as those in the 2017 plan.

Action Item Development Process

Development of action items was a multi-step, iterative process that involved brainstorming, discussion, review, and revisions. Action items can be developed through a number of sources. During the 2023-2025 MJ-NHMP update process, the jurisdictions used existing master planning documents as a source for mitigation strategy action development.

Many of the existing action items were first created during previous MJ-NHMP planning processes. Prior steering committees used maps developed by the Oregon Partnership for Disaster Resilience of local vulnerable populations, facilities, and infrastructure in respect to each identified hazard. Reviews of these maps generated discussion around potential actions to mitigate impacts to vulnerable areas. The mitigation strategy actions were divided into Priority Actions and other actions with lower priority or fewer available resources. These were identified as Pool Items from which to draw in future hazard mitigation planning efforts.

During the 2023-2025 MJ-NHMP update process, the jurisdictions met in small groups to review all the mitigation strategy actions in conjunction with the updated risk assessment. The group began by considering the status of each action as a starting point for the discussion of mitigation strategy. The DLCD project manager and the small jurisdictional groups discussed how to make each action better reflect the mitigation strategy action relevant and applicable to each jurisdiction. This involved revising some action descriptions to make them SMART, or Specific, Measurable, Actionable, Realistic, and Time sensitive. During these small group meetings, new mitigation strategy actions were identified. All actions were then reviewed by the Steering Committee and further revised as necessary.

An opportunity for review and feedback on this mitigation strategy by the public, including neighboring jurisdictions, was also provided. Additional planning process documentation is in Appendix A.

Mitigation Strategy Actions

Mitigation Strategy Action items identified through the planning process are an important part of the mitigation strategy. These action items describe activities or projects that local jurisdictions can implement to reduce risk. Some of these actions are ongoing and are conducted as a part of existing staff duties usually funded through existing budgets. Other actions are initiated and completed as discrete projects or activities that require grant or loan funding. Each action consists of a description and often additional notes to further detail the action item. A coordinating department or position and supporting agencies both internal and

external are identified for each action as is the anticipated timeframe for implementation, potential funding sources, and priorities when they are known.

The process of identification involved referencing relevant master planning documents, such as Water Master Plans, Stormwater Management Plans, Flood Management Plans, Capital Improvement Plans, and the Linn County Community Wildfire Protection Plan, to identify priority actions that are supported by the jurisdiction's administration, that address high risk hazards, and that have available or identified resources. The process of prioritization can also involve methodical approaches such as Benefit/Cost Analysis, Cost Effectiveness Analysis, and the STAPL/E Approach, a quick evaluation of options to determine which warrant a more detailed analysis. All three of these methods are discussed in Appendix C: Economic Analysis of Natural Hazard Mitigation Projects. Further action item prioritization will take place during Plan Maintenance meetings. The Plan Implementation and Maintenance process is further detailed in Section 4.

Methods for using other projects to move mitigation strategies forward include dovetailing mitigation improvements with existing planned projects. An example was given using the opportunity during culvert and bridge replacement when overhead utilities must be bypassed to complete the roadway improvements to make those bypasses permanent.

Mitigation Strategy Action items for Linn County are included below. Mitigation Strategy Action items for the cities of Gates, Halsey, Harrisburg, Lebanon, Lyons, Millersburg, Scio, Sodaville, Sweet Home, and Tangent, and the Lyons Rural Fire District are in each of the addenda in Volume II: City and District Addenda.

Action Item Tables

The Mitigation Strategy Action Item tables present three groups of actions. Table 3-1 identifies actions that have been completed since 2017, and Table 3-2 identifies action items that were removed from the Plan and the reasons for removing them. Table 3-3 identifies ongoing mitigation actions, and Table 3-4 identifies short-term, medium-term, and long-term mitigation actions sorted by hazard.

The table columns provide information identified by each jurisdiction about the action status, the priority level (if known), the coordinating organization or department, an estimated timeline, potential funding sources, and notes with additional relevant details. During the plan maintenance or implementation phase of this project, the Convener and the plan update or maintenance committee may use these tables to track progress and lay out next steps for implementing the mitigation strategy.

OEM can provide resources and information to assist jurisdictions with successfully obtaining FEMA funding for mitigation projects. The Mitigation and Recovery Coordination Team of OEM's Regional Coordinators Program employs specialized field staff members to support local and Tribal emergency management partners through all areas of emergencies and disasters. Additionally, the State Hazard Mitigation Officer and Deputy Hazard Mitigation Officers are available to discuss potential mitigation projects, funding opportunities, and eligibility.

Table 3-1. Completed Mitigation Strategy Actions – Linn County

2017 Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Status	Notes
MH-Bridge 1a	Develop a County wide list of all public bridge crossings leading to private structures on private and public lands.	Road Department	Emergency Management, Fire Districts, Linn County Fire Defense Board, private landowners, Public agencies	Complete	The Road Dept & GIS Dept have lists of all bridges under county jurisdiction. ODOT has their own list of bridges under ODOT jurisdiction, as well as other bridge types (city, federal, etc.)
SW-1a	Inventory public and semi-public infrastructure and critical facilities and evaluate for vulnerability to severe weather.	Emergency Management	Road Dept.; Planning & Building Dept.; Assessor; GIS; Health Dept.; General Services; Emergency Service Providers; ODOT; OEM; FEMA; Insurance Companies; Utility Companies	Complete	DOGAMI Multi-hazard Risk Assessment provides detailed information on vulnerability of county and city critical facilities and lifeline services.
WF-1	Update the Community Wildfire Protection Plan	Linn County Planning and Building Dept & Emergency Management	ODF - North & South Cascade Districts; Emergency Management; United States Forest Service- Willamette National Forest; Bureau of Land Management; Linn County Fire Defense Board; Fire Districts; Cities; Oregon State Fire Marshal; OEM; Watershed Councils; OSU Extension	Complete	CWPP updated in 2022-2024, adopted March 2024. The next update cycle should be timed with the NHMP, possibly conducted in concurrent review. See Hood River County as an example of a concurrent NHMP/CWPP process.

Table 3-2. Mitigation Actions Removed from Linn County Mitigation Strategy

2017 Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Status	Notes
FL-1	Update Flood Insurance Rate Maps (FIRM)	Planning & Building Department	Building Official; Emergency Management; Insurance Companies; Cities; FEMA; OEM; GIS	Remove	Updated 2010 and 2015
MH-4	Encourage small businesses to develop continuity of business plans in the event of a disaster and to implement non-structural mitigation.	Cascade West Council of Governments	Business Development Coordinator; LBCC Business Development; Red Cross	Remove	Not within County scope.
EQ-4	Assist K-12 schools, child care facilities and private schools to develop vulnerability assessment and mitigation projects to improve safety.	Cities	Emergency Management; Health Department; School Districts; Private Schools; American Red Cross; DOGAMI; OEM; Oregon Department of Education	Remove	Outside county scope. The County has official relationships with 3 schools/districts- Santiam SD, Harrisburg SD and Pioneer Christian (Brownsville) for emergency facility sites, so these locations could be partnered with individually.
DR-2	Support local agency programs for farmers and ranchers that provide education and training on water conservation measures, including drought management practices for crops and livestock.	Planning & Building Department	OSU Extension Services; NRCS; Farm Bureau; WRD; ODFW; Watershed Councils; Water Districts	Remove	Outside of county scope
LS-3	Increase public education related to landslide hazards by distributing DOGAMI landslide informational brochure.	Department of Health Services - Emergency Preparedness Coordinator	CERT; Planning Dept.; Dept. of Forestry; DOGAMI; OEM; ODOT; Road Department; Radio Stations	Remove	Merged with MH-3

2017 Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Status	Notes
MH-2	Publicize opportunities for appropriate staff to attend FEMA G318 local mitigation planning workshops or related trainings.	Emergency Management	OEM; DOGAMI; FEMA; Fire Marshall; Insurance Companies; Linn County Roads; Linn County Facilities Manager	Remove	Already done by OEM
EQ-3	Train 10-20 county staff through ATC 20/145 Damage Assessment Classes over the next 5 years	Emergency Management	OEM	Remove	This action is less relevant today given the advancement in damage assessment methods and software such as Survey123. Having the appropriate equipment is the roadblock to using these methods
MH-Bridge 6	Work with private bridge owners to mitigate particularly vulnerable private bridges	Road Department	Planning and Building; Linn County Fire Defense Board; Private landowners; Public agencies; Fire districts?	Remove	Road Dept does driveway inspections and informs private landowners that bridges have to meet Fire Code as dictated by the Fire Department. Removed as there is no clear path to funding for private owners for inspections, engineering, or retrofitting.
MH-Bridge 3	Implement County's existing bridge *scour protection* plan, targeting 5-10 high priority bridges every year (as identified in MH-Bridge 2).	Road Department	GIS Department	Remove	Combined with MH-Bridge 4. FLAP funding awarded to replace 5 bridges on Upper Calapooia Rd for FY 27-30.
SW-1b	Mitigate the vulnerable structures identified in SW-1a. Target 5 mitigation projects per year.	General Services	Emergency Management; Health Dept.; ODOT; OEM; FEMA; Insurance Companies; Utility Companies	Remove	Replaced with a new MH item for mitigating temporary use shelter sites.

Table 3-3. Ongoing Mitigation Strategies – Linn County

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
MH-Bridge 1b	Maintain a County wide list of all public bridge crossings providing access to private structures on private and public lands, including weight restricted bridges	Road Department	Emergency Management, Fire Districts, Linn County Fire Defense Board, private landowners, Public agencies	Ongoing	New Action	Road Fund	Follow up to MH-Bridge 1
WF 3 (CWPP Action #2.1)	Collect and distribute educational materials regarding fire-resistant construction materials and techniques, fire code standards for access, water supply and fuel breaks, defensible space recommendations and fire-resistant vegetation and landscaping to homebuilders and county residents.	Planning & Building Department	CWPP Advisory Committee, Linn County Fire Defense Board; Emergency Management; Homebuilder and Real Estate Organizations;	Ongoing	New Action	CWDG, Operating Budget	
MH-Bridge 2	*Evaluate* public bridges identified in MH-Bridge 1 for flood, scour, seismic and structural integrity *and rank bridges by vulnerability.*	Road Department	General Services; Board of Commissioners; FEMA; DOGAMI; OEM; ODOT; U.S. DOT	Ongoing	Retain	Road Fund	This is an ongoing task now on a regular schedule. Bridges over 20 feet long are being evaluated by ODOT- biannually or annually- NBI (National Bridge Inventory). Bridges under 20 feet long (non-NBI) within the Linn County jurisdiction are inspected by the Road Department on a 2-year basis by County Bridge crew using the same inspection criteria as ODOT.

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
MH-1 a	Develop mutual aid agreements with private parties	Emergency Management	Health Dept. - Emergency Preparedness Coordinator; Road Dept.; ODOT; ODF; Private timber owners; private landowners	Ongoing	Retain, progressing	Current Sheriff's Office funding	Developing agreements is an ongoing effort. The county has established a number of agreements for a number of services including Emergency Site Usage. Among them are 3 School Districts. There is an agreement with Knife River for activation during flooding where Knife River will send free sand to the Emergency Manager and the EM will provides bags to make sandbags. A phone app was developed to assist in distribution. Prior action identified documentation of equipment, labor, and special expertise available to mobilized rapidly in the event of a natural disaster. Agreements could also include maps of private parties' operating areas.
MH-3	Develop new material that relates in impact on health from natural hazard events. Incorporate the latest reliable data into public information messages. Maintain public awareness campaigns aimed at homeowners, children, the elderly, and non-English speaking residents to raise awareness about disaster	Department of Health Services - Emergency Preparedness Coordinator	Emergency Management; Red Cross; COGl Cities; Linn Benton ESD; United Way; State Agencies (DEQ, DOGAMI); Hospitals; Insurance Companies; Children and	Ongoing	Retain, progressing	Current department funding,	The Health Department has improved the methods used for public information and outreach. A series of scripted messages were developed and are posted by the PIO as needed. The department maintains a relationship with OHA that allows for data on vulnerable people in the county to be kept up to date. The most reliable data on heat island effects, poor air quality

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
	preparedness and risk reduction.		Families Commission				and debris flow hazards are available from partner agencies.
MH-Bridge 5	Implement a routine public bridge inspection program for bridges identified in MH-Bridge 1 and revisit bridge vulnerability ranking as necessary.	Road Department	Planning and Building; Linn County Fire Defense Board; Private landowners; Public agencies	Ongoing	Retain, progressing	Road Fund	Started the inspection cycle and idea is to maintain this inspection routine consistently- evaluating every non-NBI bridge at least one time every 2 years. ODOT covers NBI bridges. All bridges under Linn County's jurisdiction are inspected at a frequency of every two years. Some bridges are inspected annually if there is a cause for that inspection frequency. ODOT is responsible for evaluation of the structural sufficiency of these bridges. Road Dept maintains sufficiency ratings for all bridges.
FL-5	Buy out properties in areas vulnerable to flooding as they become available.	Planning & Building Department/Floodplain Administrator	Linn County Property Management; Parks Department; Road Department; Board of Commissioners; US Army Corps of Engineers	Ongoing	Retain	FEMA BRIC, FEMA HMGP, FEMA FMA, CDBG Disaster Recovery Program	The County has done an acquisition of substantial loss property once in the last 15 years. There are funding streams that could support this action if there is an opportunity to reduce flood risk or need, see: https://crsreports.congress.gov/product/pdf/IN/IN11911
FL-6	Encourage and collaborate on multi-objective stream and river enhancement projects that maximize flood mitigation.	Road Department	Cities; Emergency Management; Watershed Councils; Water	Ongoing	Retain	Road Fund, OWEB grants	Road Dept and Calapooia/North Santiam/South Santiam Watershed Councils have collaborated to complete bank

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
			Control Districts; DSL; ODFW; DOF; DEQ; FEMA; USACE; Planning and Building Department				stabilization projects along public road areas. Also fish passage projects through culvert replacement or bridge installment projects. Depending on the project/grant has involved county doing their own improvements.
EQ-1b	Implement at least 1 structural mitigation project for prioritized, vulnerable publicly owned structures identified in EQ-1a per year.	General Services	Road Department; Building Official; OEM; Assessor; DOGAMI; Safety Committee	Ongoing	Retain	State Seismic Rehabilitation Grant Program, FEMA BRIC	Added a target goal
MH-Bridge 4	Implement *structural mitigation* projects and bridge scour protection for prioritized, vulnerable publicly owned bridges as identified in MH-Bridge 2. Target 1-2 mitigation projects per CIP budget cycle.	Road Department	General Services; Board of Commissioners; FEMA; DOGAMI; OEM; ODOT; U.S. DOT	Ongoing	Retain, revised	ODOT Local Bridge Program, FLAP Grant (Western Federal Lands Access Program), Federal Highway Admin. grants, and Road Fund	Annually the Road Dept applies for grants. There is both a running list of problematic bridges and emergent projects identified from recent inspection reports, including scour critical bridges. The "Scour Protection Plan" is not referenced anymore. The 2018 TSP identifies several bridge projects based on evaluations that do not have an identified funding stream. We should consider going down the list to specifically name the bridge projects that have not been planned/funded. Linn County's Engineering Division has completed 5 structural rehabilitations or full bridge

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
							replacements in the last three years
WF-2 (CWPP Action #3.2)	Partner with the Oregon Department of Forestry and Rural Fire Districts to promote home site assessment programs for the wildfire hazard, prioritize vulnerable populations within the WUI and provide homeowners and renters with applicable fire-safety resources.	Linn County Juvenile Department	ODF; Linn County Fire Defense Board; Local Fire Districts; Cities; Fire Marshal; OEM; Emergency Management	Ongoing	Retain, revised to align with CWPP	CWDG, OSFM CWRR	Juvenile Dept. currently operates a fuels reduction crew that assist primarily elderly and disabled residents within the County. This program could be expanded/secured for the longer term with additional funding.

Table 3-4. Short-term, Medium-term, and Long-term Mitigation Actions for Linn County Sorted by Hazard

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
MH-1b	Develop a database to track the agreements using software already available.	Emergency Management		Short term, 1-3 years	New Action	ODEM Technical assistance could assist in identifying potential funding sources	Tracking a number of aspects of the agreements to better manage for continuity of collaboration.

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
MH-5 (incorporates CWPP Action #2.8)	Re-evaluate the Goal 7 section of the Linn County Comprehensive Plan and update policies to incorporate mitigation principles.	Planning & Building	DLCD; OEM; DOGAMI	Short term, 1-3 years	Retain	DLCD Technical Assistance, FEMA HMGP 5% Codes & Standards	This was identified as an action item in the CWPP- 2.8 for a Comprehensive Plan audit to align Goal 7 Element w/ statewide wildfire legislation. Should expand to address multi-hazards (review floodplain, geologic hazards, etc.)
MH-6	Update replacement costs on the existing County Asset Inventory(s) at least every 5 years.	General Administration	Linn County Property Management; Treasurer; Assessor; GIS; Road Department; Health Department	Short term, 1-3 years	Retain, revised	General Fund & Department Budgets	Each Department/Office has their own inventory/asset management process, and it is decentralized. The County could benefit from a streamlined inventory of important assets that is submitted to a central source and updated on a routine basis. This would help in post-disaster situations and also be an information source for grant writing, project prioritization.
MH-7 (integrates CWPP Action #1.10)	Equip emergency use sites with generators, air scrubbers, proper heating/cooling systems, and pre-stage supplies on-site or in portable trailers to ensure site resiliency during mass care/shelter events.	Linn County Department of Health Services - Emergency Manager	Emergency Management; Cities (Sweet Home, Harrisburg, Mill City, Brownsville); School Districts (Santiam School District, Harrisburg School District, Pioneer Christian); Linn County Fairgrounds; LBCC; DHS, OHA	Medium-term; 3-5 years	New Action	ODHS Resiliency Hub Grants	Linn Co. has just started to establish emergency site agreements in local communities and is currently building those relationships, testing out agreements. As these relationships develop, it will be important to ensure that each site is well-equipped to handle hazardous weather/power outages.

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
MH-8 (integrates CWPP Action #2.7)	Identify opportunities and barriers to support hazard-vulnerable populations (e.g. low-income, elderly, disabled, non-English speaking) through outreach to communities and service providers. Work to embed disaster preparedness within ongoing community health education efforts using materials designed in MH-3.	Linn County Department of Health Services - Emergency Manager	Emergency Management, Regional Healthcare Coalition, Linn County Public Health Outreach Group, Linn Benton Lincoln Health Equity Alliance, local healthcare providers	Short term, 1-3 years	New Action	Operating Budget, ODHS grants, private foundation and public health grants	Adapted from priority CWPP action item into a broader, multi-hazard item.
MH-9	Improve emergency response efforts in Linn County by auditing local address points in GIS for accuracy.	GIS Department	Cities; Fire Districts; Linn County Dispatch	Short term, 1-3 years	New Action	County & City Local Operating Budgets	The GIS Department has a current project to audit all Linn County unincorporated addresses in order to remove abandoned addresses, update address points locations for accuracy, etc. This project could be extended to local jurisdictions who do not do their own addressing. These jurisdictions include but are not limited to: Tangent, Scio, Sodaville, Waterloo.
MH-10	Upgrade or build new facilities that would serve as emergency services infrastructure	Emergency Management	Sheriff's Office; Board of Commissioners; General Administration	Medium-term; 3-5 years	New Action	FEMA BRIC; Capital Improvements Funding	There is currently no seismically resilient dedicated EOC.
MH-11	Identify key areas in East Linn County with communication "dead zones" and implement targeted solutions to enhance emergency operation including installing additional radio	Linn County Sheriff's Office	Linn County Dispatch; Linn County Fire Defense Board	Long-term; >5years	New Action		These improvements will strengthen communication between emergency responders, county services, and residents during wildfire & other natural hazard events, ensuring prompt and coordinated actions

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
	repeater towers, upgrading existing radio infrastructure, and deploying mobile communication units when necessary.						
MH-12	Seek funding for local training on mitigation and recovery	Emergency Management	OEM	Short term, 1-3 years	New Action	OEM Technical Assistance	Local training is more relevant for emergency responders
MH-13	Seek funding for equipment to allow the use of modern damage assessment software during recovery operations.	Emergency Management	OEM	Short term, 1-3 years	New Action	OEM Technical Assistance	
MH-14	Evaluate vulnerability of people, infrastructure, critical facilities, and other community assets to drought, extreme heat, smoke/poor air quality, windstorms/tornadoes, and winter storms/ice storms. Upon identification of specific jurisdictional assets that are vulnerable to the hazards profiled, identify the potential impacts to those assets from the hazards. Conduct analysis for county and in conjunction with cities.	Linn County EM	Linn County Planning, Roads, Health Dept., OWRD, OEM, DLCD	Long-term; 4-5 years	New Action	County Budget, DLCD Technical Assistance Grants, OEM, FEMA	
MH-15	Identify a methodology and needed resources for analyzing how changes in development intersect with identified hazards to determine if development	Linn County EM	Linn County Planning and GIS, OEM	Long-term; 4-5 years	New Action	County Budget, DLCD Technical Assistance	County to conduct analysis in conjunction with cities.

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
	has occurred in, or adjacent to, hazard-prone areas, and conduct analysis for the county and cities during the next NHMP update if resources are available.					Grants, OEM, FEMA	
DR-1	Partner with local water districts and watershed councils to develop and adopt a Drought Contingency Plan for Linn County's South Santiam Watershed and/or Calapooia Watershed.	General Administration	Local Cities (Albany, Lebanon, Sweet Home); Watershed Councils; Emergency Management; NRCS; Department of Agriculture; WRD; Local Water Districts; Parks and Recreation Dept.;	Short term, 1-3 years	Retain, revised	WaterSMART Drought Resiliency Grant	Linn County experienced a Drought Declaration in 2021. The North Santiam Watershed (primarily in Marion County) created a plan in 2017 and is currently updating it in 2024. Could serve as a model for the South Santiam and/or Calapooia Watershed. Example: https://northsantiam.org/projects/north-santiam-drought-contingency-planning-2016-2017/.
EQ-1a	Conduct a seismic vulnerability assessment of critical County owned structures and prioritize structures critical to the continuity of operations during a natural hazard and community lifelines.	General Administration	Emergency Management; Road Department; Building Official; OEM; Assessor; DOGAMI; Safety Committee; Sheriff's Office; Linn County Fairgrounds & Expo Center; Linn County Road Department	Short term, 1-3 years	Retain, revised	FEMA BRIC, FEMA HMGP	Revise language to focus on essential structures for emergency purposes. Revised lead to higher level at the County since facilities are not solely managed by General Services- including critical facilities managed by Sheriff's Office, Fairgrounds, etc.

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
EQ-2	Maintain quarterly safety inspections of County staff offices and workspaces to implement non-structural retrofits and develop an internal county emergency earthquake training program.	Safety Committee	General Services; County Insurance Carrier; OEM; OR-OSHA; BC	Short term, 1-3 years	Progressing, revise	County Operating Budget	The Safety Committee has established a quarterly inspection schedule which includes checking County staff and office workspaces for seismic risks- ensuring heavy furniture is secured or screwed down, exits cleared, etc. Revise item to add new focus on developing trainings to educate each department/office on earthquake preparedness/workplace safety.
FL-2	Digitize LOMA/LOMR and elevation certificates countywide.	GIS Department	Cities	Short term, 1-3 years	Progressing, retain	County & Local City Operating Budgets	The backlog of LOMAs/certificates for unincorporated lands under County jurisdiction has been digitized, GIS now does ongoing upkeep of this when new documents are received. City of Scio already sends over certificates when received and GIS Department digitizes these for the County Mapping system. GIS Department could continue this work with other local jurisdictions, first catching up the backlog of documents then doing on going upkeep.

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
FL-3	Fund a new hydraulic study for Linn County.	Road Department	Surveyor; GIS; Floodplain Manager; FEMA;	Medium-term; 2-5 years	Retain	FEMA FMA	Recommend retaining after discussions with GIS Department. The hydrologic conditions in Linn County have changed in some areas over the years due to new infrastructure (culvert installation, new holding ponds, etc.) which can greatly change the trajectory of flooding water. Conducting a hydraulic study of specific areas in the County- such as: Knox Butte area outside Albany, Kingston area in North Linn County, etc., in particular targeting "A" flood zones to get a better understand of flood risk and potentially submit LOMAs for non-affected areas. This would help in the long run to redirect flood risk reduction efforts to more impacted areas and lower costs to homeowners and County.
FL-4a	Create a list of river and stream scour locations that impact county roads and prioritize areas for stabilization.	Road Department	GIS Department, Watershed Councils	Short-term; 1-2 years	Retain	Road Fund, OWEB grants	Slightly revised to identify the task to be completed (create a list).
FL-4b	Stabilize priority road areas identified in FL-4a.	Road Department	GIS Department, Watershed Councils	Medium-term; 3-5 years	Retain	Road Fund, OWEB grants	
LS-1a	Identify landslide and rock fall areas adjacent to public roads and prioritize areas for stabilization/mitigation.	Road Department	GIS Department	Short-term; 1-3 years	Retain	Road Fund	There are known problem locations for geological hazards, however this is not a formalized inventory. Road improvement projects that are visually assessed as having potential geologic hazards (e.g. sliding, erosion,

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
							etc.) are typically evaluated by a geotechnical engineer before the Road Department undertakes major work.
LS-1b	Stabilize priority areas identified in LS-1a.	Road Department	GIS Department	Medium-term; 3-5 years	Retain	Road Fund	
LS-2a	Collect and use the most recent landslide data to understand landslide risk and geologic hazards in Linn County.	GIS Department	DOGAMI	Short-term; 1-3 years	Retain, revised	USGS Landslide Risk Reduction Grants	The latest LIDAR imagery available for Linn County is from 2009, and it is very expensive to collect new data. Localized, high-quality LIDAR data would be beneficial to developing a localized landslide hazard dataset to replace the current landslide hazard maps from the 1970s. (New LIDAR is also beneficial data for assessing other hazards such as flooding). DOGAMI makes available the most up to date, reliable data on landslides including debris flow areas through SLIDO (Statewide Landslide Inventory Database for Oregon), but their current risk mapping is regional and not recommended for localized use. Additional post-fire debris flow mapping is being developed by DOGAMI and will be available for north Linn County (Beachie Creek/Lionshead Fire footprint). Although these maps are not regulatory, the county may determine that it will be used to apply reasonable and objective standards

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
							for siting and construction of development. See: https://www.oregon.gov/dogami/Landslide/Documents/Landslide_Hazards_Land_Use_Guide_2019.pdf
LS-2b	Update the Linn County Land Development Code to mitigate risks to people and property is landslide hazard areas identified in LS-2a.	Planning Department	GIS Department	Medium-term; 3-5 years	Retain, revised	DLCD Technical Assistance, FEMA HMGP 5% Codes & Standards	Utilizing data collected and/or considered from LS-2a, the County should make updates to the Land Development Code to limit or mitigate risk of development in high hazard landslide areas. Special care should be taken to develop clear and objective standards for housing in geologic hazard areas.
SW-2	Purchase and implement the use of live tracking software for snowplows and winter weather responses.	Emergency Management	Road Department; General Services; Parks Department	Short-term; 1-3 years	New Action	ODHS-OREM's resiliency hub grant	The objective of this action would allow first responders to know how best to navigate the road network following a winter storm or windstorm to be able to get to work.
WF-4 (CWPP Action #5.3)	Hire a Hazard Mitigation and Recovery coordinator position to implement priority described in the NHMP and CWPP.	Emergency Management	CWPP Advisory Committee; Linn County Fire Defense Board; ODF	Short-term; 1-3 years	New Action	CWDG	
WF-5	Conduct a mid-term review of the CWPP to track progress and to identify potential sources of funding for an update in 2029.	Linn County Planning and Building Dept & Emergency Management	Emergency Management; ODF; USFS; BLM; Fire Districts; Fire Marshal	Short-term; 2-3 years	New Action	County General Fund, CWDG, FEMA HMGP	Integration of statewide wildfire hazard maps and more site-specific risk assessments / evaluations
WF-6 (CWPP	Increase evacuation preparedness in high-risk Wildland Urban Interface areas	Emergency Management	CWPP Advisory Committee; Linn County Fire	Medium-term; 1-5 years	New Action	CWDG, OSFM Community Risk	Priority action item in the CWPP.

Hazard ID	Action Title	Lead Organization	Partner/ Supporting Organizations	2024 Timeline	2024 Status	Potential Funding Sources	Notes
Action #1.5)	through distribution of educational materials, community workshops, and support community-led efforts to establish Firewise Communities.		Defense Board; OSFM			Reduction (CWRR)	
WF-7 (CWPP Action #4.6)	Implement landowner assistance programs to support creating defensible space around communities and homes of residents from vulnerable population groups (i.e. elderly, disabled, low-income).	Linn County Juvenile Department	Community Services Consortium, Fire Districts, ODF, Santiam Canyon Long Term Recovery Group	Medium-term; 1-5 years	New Action	CWDG, OSFM CWRR, FEMA HMGP, Title III Funds	Priority action item in the CWPP.
WF-8 (CWPP Action #3.3)	Share information about state fire hardening building code standards for voluntary use and seek funding for a home hardening cost-share/incentive program for Linn County residents in the WUI or high-priority areas identified in the CWPP.	Planning & Building Department	Oregon Building Codes Division; OSFM;	Medium-term; 3-5 years	New Action	CWDG, OSFM CWRR, Building Codes Division Fire Hardening Grants, FEMA HMA	
WF-9 (CWPP Actions #3.4 & 4.11)	Create defensible space & building hardening retrofits on and around critical infrastructure sites in the WUI and priority areas at risk identified in the CWPP.	Emergency Management	Linn County Juvenile Department; Cities; Fire Districts; Sheriff's Office; Linn County Parks & Recreation Department	Medium-term; 3-5 years	New Action	CWDG, OSFM CWRR, FEMA HMGP, Title III Funds	Priority action item in the CWPP.

SECTION 4:
PLAN IMPLEMENTATION AND MAINTENANCE

The Plan Implementation and Maintenance section details the formal process that will ensure that the Linn County MJ-NHMP remains an active and relevant document. The plan implementation and maintenance process include a schedule for monitoring and evaluating the Plan semi-annually, as well as producing an updated NHMP every five years. Finally, this section describes how the county will integrate public participation throughout the plan maintenance and implementation process.

Implementing the Plan

The success of the Linn County MJ-NHMP depends on how well the outlined action items are implemented. Following formal adoption of the Plan, the following steps will be taken to ensure identified activities are implemented: 1) the Steering Committee will become the coordinating body for the MJ-NHMP; and 2) the Linn County Convener will plan for two opportunities per year to update the Plan, prioritize and evaluate mitigation actions, and coordinate implementation actions. The NHMP will be implemented largely through existing plans, programs, and policies.

Plan Adoption and Approval

The Linn County MJ-NHMP was developed and will be implemented through a collaborative process. After the Plan was reviewed and deemed complete by the Co-conveners and the Steering Committee members, the DLCD Project Manager submitted it to OEM for review. Following any required revisions, OEM submitted the NHMP to FEMA Region X for final plan review. This review addresses the federal criteria outlined in the FEMA Interim Final Rule 44 CFR Part 201. When FEMA Region X was satisfied that the Plan met all federal requirements, the agency issued the Approvable Pending Adoption (APA) letter. After receiving the APA letter, the County Board of Commissioners adopted the plan via resolution. The resolution was then transmitted to FEMA, after which FEMA issued its approval letter. The approval letter establishes the validity of the MJ-NHMP and makes the county eligible for FEMA grant programs. Following adoption by the county, each of the participating cities and district local convened their respective decision makers (City Councils and Boards of Directors) and adopted the Linn County Multi-Jurisdictional NHMP. An updated FEMA approval letter is issued after each adoption resolution is received by FEMA, and is included at the front of this plan.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and adopted via resolution of the Linn County Board of Commissioners on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

Convener

The Linn County Emergency Manager serves as convener for the Linn County MJ-NHMP. The Linn County Planning Manager and her staff were instrumental in the development of this update; however, the convener role will now rest solely with the Emergency Manager within the

Linn County Sheriff's Office. The Convener will take responsibility for plan implementation, for facilitating the Hazard Mitigation Coordinating Body meetings, and for assign tasks during the implementation process. Plan implementation and evaluation will be a shared responsibility among all of the assigned Coordinating Body members. The Convener's specific responsibilities include:

- Coordinating Steering Committee meeting dates, times, locations, agendas, and member notification;
- Documenting the discussions and outcomes of committee meetings;
- Serving as a communication conduit between the Steering Committee and the public/stakeholders;
- Identifying emergency management-related funding sources for natural hazard mitigation projects; and
- Utilizing the Risk Assessment as a tool for prioritizing proposed natural hazard risk reduction projects.

Coordinating Body

The Linn County Steering Committee will form a Natural Hazard Mitigation Coordinating Body for updating and implementing the NHMP. Coordinating Body responsibilities include:

- Attending future plan maintenance and plan update meetings (or designating a representative to serve in your place);
- Serving as the local evaluation committee for funding programs such as the Pre-Disaster Mitigation Grant Program, the Hazard Mitigation Grant Program funds, and Flood Mitigation Assistance program funds;
- Prioritizing and recommending funding for natural hazard risk reduction projects;
- Evaluating and updating the NHMP in accordance with the prescribed maintenance schedule;
- Developing and coordinating ad hoc and/or standing subcommittees as needed; and
- Coordinating public involvement activities.

Members

Representatives from all the participating jurisdictions, and Linn County Partners and Interested Parties who joined in the update of the plan may continue to serve on the Linn County MJ-NHMP Coordinating Body during the implementation and maintenance phase. For a list of individuals see the Acknowledgements page of this plan. Among the departments within Linn County government, the following participated in updating the MJ-NHMP:

- Linn County Emergency Management
- Linn County Planning and Building Department
- Linn County Public Health
- Linn County Road Department (County Engineering)

To make the coordination and review of the Linn County MJ-NHMP as broad and useful as possible, the Coordinating Body will engage additional stakeholders and other relevant hazard mitigation organizations and agencies to implement the identified action items. Specific

organizations have been identified as either lead or supporting partners on the individual action items found in Volume I, Section 3, and in Volume II: City and District Addenda.

Implementation through Existing Programs

The NHMP includes a range of action items that, when implemented, will reduce loss from hazard events in the county. Within the plan, FEMA requires the identification of existing programs that might be used to implement these action items. Linn County and the participating cities currently address statewide planning goals and legislative requirements through their comprehensive land use plans, capital improvement plans, transportation system plans, and mandated standards and building codes. To the extent possible, Linn County and participating cities will work to incorporate the recommended mitigation action items into existing programs and procedures.

Many of the recommendations contained in the NHMP are consistent with the goals and objectives of existing plans and policies for the participating cities, district, and the county. Where possible, Linn County and the cities and district should implement the recommended actions contained in the NHMP through existing plans and policies. Plans and policies already in existence often have support from local residents, businesses, and policy makers. Many land use, comprehensive, and strategic plans get updated regularly, and can adapt easily to changing conditions and needs. Implementing the action items contained in the NHMP through such plans and policies increases their likelihood of being supported and implemented.

In addition to integration through existing plans and policies to achieve mitigation, continued coordination during the Plan Maintenance period between Linn County and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the county and jurisdictions' mitigation strategies. The County has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, there are identified mitigations actions that will help to increase overall mitigation capability of the county and jurisdictions.

Examples of plans, programs, or processes that may be used to implement mitigation activities include:

- City and County Budgets
- Community Wildfire Protection Plans
- Comprehensive Land Use Plans
- Economic Development Action Plans
- Zoning Ordinances
- Building Codes – Oregon State Building Code is a uniform statewide building code managed by the state's Building Codes Division and implemented at the local level.

Active plans and policies of each of the cities and district that are relevant to natural hazards mitigation are outlined in the respective City and District Addenda included in Volume II.

The following Linn County plans and policies are relevant to natural hazards mitigation:

Linn County Comprehensive Plan

Date of Most Recent Revision: 2016

Author/Owner: Linn County

Description: Provides a general path for the course of growth and development of Linn County. The Comprehensive Plan is charted by the map, goals, and policies of this Comprehensive Plan in conjunction with the comprehensive plans of the cities in Linn County.

Relationship to Natural Hazard Mitigation Planning: The Linn County Comprehensive Plan guides land use within the county. Goals of preserving resources and protecting life from hazards can be linked to action items that guide development to reduce the county's risk to natural hazards. Hazard mitigation can be linked to action items for how the County will implement Oregon Statewide Planning Goal 7 requirements.

Linn County Community Wildfire Protection Plan

Date of Most Recent Revision: 2024

Author/Owner: Linn County, with support from DLCD and ODF

Description: This plan describes Linn County's risk from wildfires as well as the specific steps that can be taken to reduce that risk now and in the future. It is a Community Wildfire Protection Plan (CWPP), a collaborative effort to reduce the potential for future loss of life and property resulting from wildfire. This CWPP is intended to assist Linn County in reducing its risk from WUI wildfire hazards by identifying resources, information, and strategies for risk reduction. It will also help to guide and coordinate mitigation activities throughout the County.

Relationship to Natural Hazard Mitigation Planning: Action items contained within the CWPP include efforts intended to mitigate losses from future wildfires and increase community resilience to wildfire.

Linn County Floodplain Management Code, Title 8 Building Code

Date of Most Recent Revision: 2016

Author/Owner: Linn County

Description: Regulations which apply to all areas of special flood hazard within the jurisdiction of Linn County, except areas within incorporated cities.

Relationship to Natural Hazard Mitigation Planning: Provisions of the Floodplain Management Code are to promote public safety and welfare and minimize flood related losses.

Linn County Transportation Plan

Date of Most Recent Revision: 2017

Author/Owner: Linn County

Description: The Transportation Plan contains brief background descriptions of facilities and issues followed by the complete list of adopted County transportation policies. In addition, sections of the Plan list prioritize proposed transportation projects.

Relation to Natural Hazard Mitigation Planning: Transportation systems assist in evacuation and response in the event of a natural hazard. Action items in the County's NHMP aimed at making the County's transportation system more disaster resistant can be linked to this Plan.

Plan Maintenance

Plan maintenance is a critical component of the NHMP. Proper maintenance ensures that this Plan will maximize the County's and participating cities' and district efforts to reduce the risks posed by natural hazards. Plan maintenance includes a process to ensure that regular review and update of the NHMP occurs. The Coordinating Body and local staff are responsible for implementing this process, in addition to maintaining and updating the plan through a series of meetings outlined in the maintenance schedule below.

Maintenance Process

The Coordinating Body will hold at least one annual meeting in person as well as a smaller meeting or group reporting activity for the second maintenance activity of the year. The Convener will minimize long meetings and focus on quick updates that are a low burden on city and district staff capacity and will include educational offerings during in person meetings. Meetings can be used as a time for guests to present training or implementation information. The time spent in plan maintenance meetings will assist city and district conveners to better understand grant process or to develop strong partnerships and collaboration among Linn County cities.

The Coordinating Body will complete the following tasks:

- Review existing action items to determine appropriateness for funding,
- Educate and train new members on the plan and mitigation in general,
- Identify issues that may not have been identified when the plan was developed,
- Prioritize potential mitigation projects using the methodology described below,
- Review existing and new risk assessment data,
- Discuss methods for continued public involvement, and
- Document successes and lessons learned during the year.

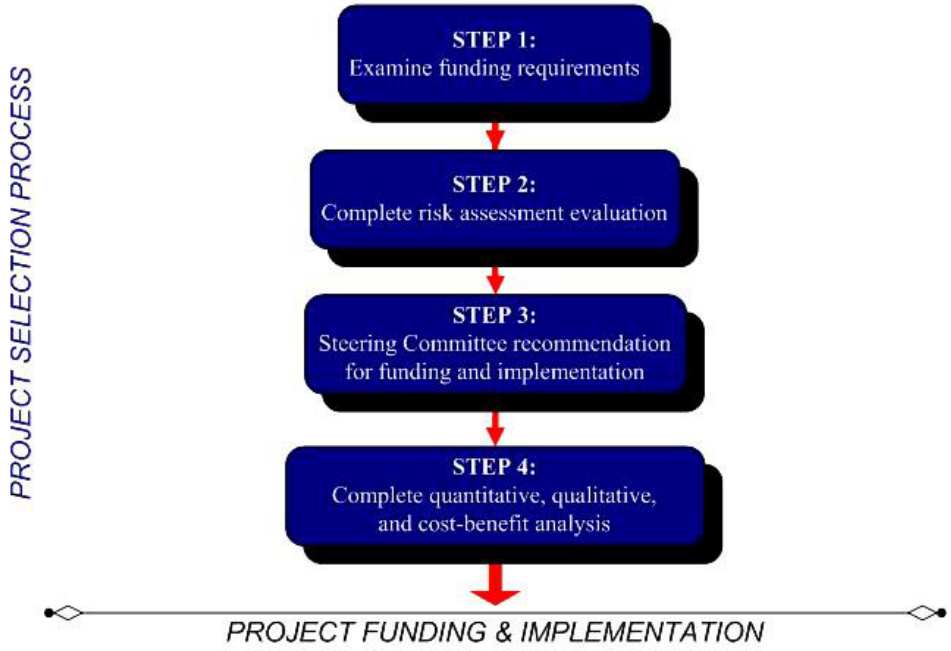
The Convener will be responsible for documenting the outcome of the annual meetings. A process the Coordinating Body may use to prioritize mitigation projects is detailed in the section below. The Plan's format allows the County and participating jurisdictions to review and update sections when new data becomes available. New data can be easily incorporated, resulting in an NHMP that remains current and relevant to the participating jurisdictions.

Project Prioritization Process

The Disaster Mitigation Act of 2000 requires that jurisdictions identify a process for prioritizing potential actions. Potential mitigation activities often come from a variety of sources; therefore, the project prioritization process needs to be flexible. Committee members, local government

staff, other planning documents, or the risk assessment may be the source to identify projects. Figure 4-1. illustrates the project development and prioritization process.

Figure 4-1. Action Item and Project Review Process



Source: Oregon Partnership for Disaster Resilience, 2008.

Step 1: Funding Requirements

The first step in prioritizing the Plan's action items is to determine which funding sources are open for application. Several funding sources may be appropriate for proposed mitigation projects. Examples of mitigation funding sources include but are not limited to FEMA pre- and post-disaster Hazard Mitigation Assistance, the National Fire Plan, Community Wildfire Defense Grant, Community Development Block Grants, state grant programs, local general funds, and private foundations, among others. See Appendix D: Grant Programs and Resources for a more comprehensive list.

Because grant programs open and close on differing schedules, the Coordinating Body will examine upcoming funding streams' requirements to determine which mitigation activities would be eligible. The Coordinating Body may consult with the funding entity, OEM, or other appropriate state or regional organizations about project eligibility requirements. This examination of funding sources and requirements will take place during the Coordinating Body's semi-annual Plan maintenance meetings.

Step 2: Risk Assessment Evaluation

The second step in prioritizing the Plan's action items is to examine which hazards the selected actions are associated with and where these hazards rank in terms of community risk. The Coordinating Body will determine whether or not the Plan's risk assessment supports the

implementation of eligible mitigation activities. This will be based on the location of the potential activities, their proximity to known hazard areas, and if community assets are at risk. The Coordinating Body will also consider whether the selected actions mitigate hazards that are likely to occur in the future, or are likely to result in severe or catastrophic damages.

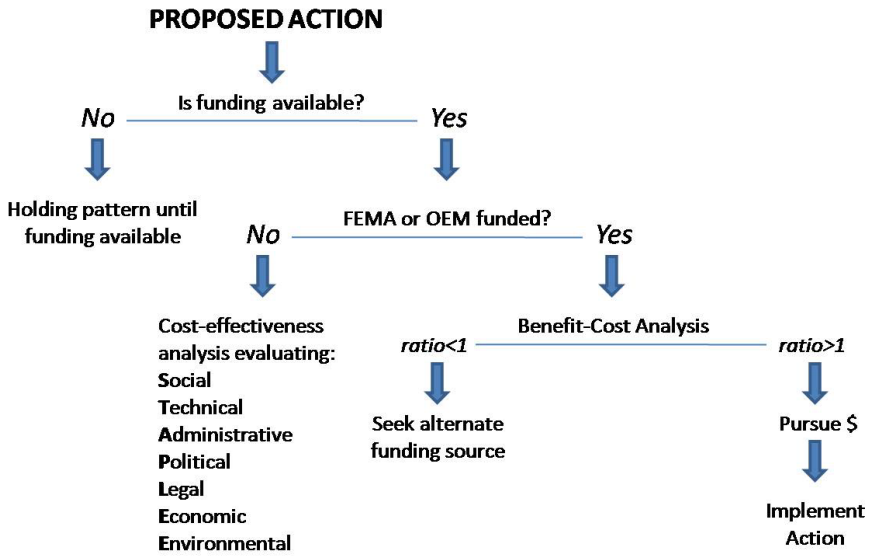
Step 3: Coordinating Body Recommendation

Based on the steps above, the Coordinating Body will recommend which mitigation activities should be moved forward. If the Coordinating Body decides to move forward with an action, the coordinating organization designated for that the action item will be responsible for taking further action and, if applicable, documenting success upon project completion. The Coordinating Body will convene a meeting to review the issues surrounding grant applications and to share knowledge and/or resources. This process will offer greater coordination and less competition for limited funds.

Step 4: Quantitative and Qualitative Assessment and Economic Analysis

The fourth step is to identify the costs and benefits associated with the selected natural hazard mitigation strategies, measures, or projects. Two categories of analysis that are used in this step are: (1) benefit/cost analysis, and (2) cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity assists in determining whether a project is worth undertaking now in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards provides decision makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects. Figure 4-2 shows decision criteria for selecting the appropriate method of analysis.

Figure 4-2. Benefit Cost Decision Criteria



Source: Oregon Partnership for Disaster Resilience, 2010.

If the activity requires federal funding for a structural project, the Coordinating Body will use a FEMA-approved cost-benefit analysis tool to evaluate the appropriateness of the activity. A project must have a benefit/cost ratio of greater than one in order to be eligible for FEMA grant funding.

For non-federally funded or nonstructural projects, a qualitative assessment will be completed to determine the project's cost effectiveness. The Coordinating Body will use a multivariable assessment technique called STAPLE/E to prioritize these actions. STAPLE/E stands for Social, Technical, Administrative, Political, Legal, Economic, and Environmental. Assessing projects based upon these seven variables can help define a project's qualitative cost effectiveness. Oregon Partnership for Disaster Resilience at the University of Oregon has tailored the STAPLE/E technique for use in natural hazard action item prioritization.

See Appendix C: Economic Analysis of Natural Hazard Mitigation Projects for further information regarding FEMA requirements for benefit cost analysis in natural hazards mitigation, as well as various approaches for conducting economic analysis of proposed mitigation activities.

Continued Public Involvement and Participation

The participating jurisdictions are dedicated to involving the public directly in the continual reshaping and updating of the Linn County MJ-NHMP. Although members of the Coordinating Body represent the public to some extent, the public will also have the opportunity to continue to provide feedback about the plan.

To ensure that these opportunities continue, the County and participating jurisdictions will:

- Post copies of their plans on corresponding websites,
- Place articles in the local newspaper directing the public where to view and provide feedback, and
- Publicize Coordinating Body and Steering Committee meetings.

In addition to the involvement activities listed above, Linn County will ensure continued public involvement by posting the Linn County MJ-NHMP on the county's website, https://www.linncountyor.gov.

Five-Year Review of Plan

This Plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. **The Linn County NHMP is due to be updated by [MONTH] [DATE], 2030.** The Convener will be responsible for organizing the Coordinating Body, or Steering Committee, to address plan update needs. The Coordinating Body will be responsible for updating any deficiencies found in the plan, and for ultimately meeting the Disaster Mitigation Act of 2000's plan update requirements.

The 'toolkit' shown in Table 4-1, below, can assist the Convener in determining which plan update activities can be discussed during regularly scheduled plan maintenance meetings and which activities require additional meeting time and/or the formation of sub-committees.

Table 4-1. Natural Hazards Mitigation Plan Update Toolkit

Question	Yes	No	Plan Update Action
Is the planning process description still relevant?			Modify this section to include a description of the plan update process. Document how the planning team reviewed and analyzed each section of the plan, and whether each section was revised as part of the update process. (This toolkit will help you do that).
Do you have a public involvement strategy for the plan update process?			Decide how the public will be involved in the plan update process. Allow the public an opportunity to comment on the plan process and prior to plan approval.
Have public involvement activities taken place since the plan was adopted?			Document activities in the "planning process" section of the plan update
Are there new hazards that should be addressed?			Add new hazards to the risk assessment section
Have there been hazard events in the community since the plan was adopted?			Document hazard history in the risk assessment section
Have new studies or previous events identified changes in any hazard's location or extent?			Document changes in location and extent in the risk assessment section
Has vulnerability to any hazard changed?			Document changes in vulnerability in the risk assessment section
Have development patterns changed? Is there more development in hazard prone areas?			Document changes in vulnerability in the risk assessment section
Do future annexations include hazard prone areas?			Document changes in vulnerability in the risk assessment section
Are there new high risk populations?			Document changes in vulnerability in the risk assessment section
Are there completed mitigation actions that have decreased overall vulnerability?			Document changes in vulnerability in the risk assessment section
Did the plan document and/or address National Flood Insurance Program repetitive flood loss properties?			Document any changes to flood loss property status
Did the plan identify the number and type of existing and future buildings, infrastructure, and critical facilities in hazards areas?			1) Update existing data in risk assessment section, or 2) determine whether adequate data exists. If so, add information to plan. If not, describe why this could not be done at the time of the plan update
Did the plan identify data limitations?			If yes, the plan update must address them: either state how deficiencies were overcome or why they couldn't be addressed
Did the plan identify potential dollar losses for vulnerable structures?			1) Update existing data in risk assessment section, or 2) determine whether adequate data exists. If so, add information to plan. If not, describe why this could not be done at the time of the plan update
Are the plan goals still relevant?			Document any updates in the plan goal section
What is the status of each mitigation action?			Document whether each action is completed or pending. For those that remain pending explain why. For completed actions, provide a 'success' story.
Are there new actions that should be added?			Add new actions to the plan. Make sure that the mitigation plan includes actions that reduce the effects of hazards on both new and existing buildings.
Is there an action dealing with continued compliance with the National Flood Insurance Program?			If not, add this action to meet minimum NFIP planning requirements
Are changes to the action item prioritization, implementation, and/or administration processes needed?			Document these changes in the plan implementation and maintenance section
Do you need to make any changes to the plan maintenance schedule?			Document these changes in the plan implementation and maintenance section
Is mitigation being implemented through existing planning mechanisms (such as comprehensive plans, or capital improvement plans)?			If the community has not made progress on process of implementing mitigation into existing mechanisms, further refine the process and document in the plan.

Source: Oregon Partnership for Disaster Resilience, 2010.

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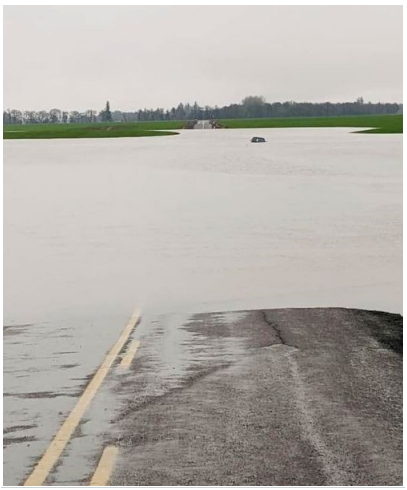


Linn County

MULTI-JURISDICTIONAL NATURAL HAZARDS MITIGATION PLAN

VOLUME II: CITY AND DISTRICT ADDENDA

2025

VOLUME II:
CITY AND DISTRICT ADDENDA

TABLE OF CONTENTS

City of Gates Addendum GA-1
Purpose GA-1
Plan Process, Participation, and Adoption GA-1
Risk Assessment GA-2
Community Profile GA-2
Hazard Profile GA-6
Hazard Analysis GA-8
Hazard Characteristics GA-10
Mitigation Strategy GA-14
Plan Implementation and Maintenance GA-18
City of Halsey Addendum HL-1
Purpose HL-1
Plan Process, Participation, and Adoption HL-1
Risk Assessment HL-2
Community Profile HL-2
Hazard Profile HL-7
Hazard Analysis HL-8
Hazard Characteristics HL-11
Mitigation Strategy HL-15
Plan Implementation and Maintenance HL-21
City of Harrisburg Addendum HB-1
Purpose HB-1
Plan Process, Participation, and Adoption HB-1
Risk Assessment HB-2
Community Profile HB-2
Hazard Profile HB-8
Hazard Analysis HB-9
Hazard Characteristics HB-11
Mitigation Strategy HB-15
Plan Implementation and Maintenance HB-22
City of Lebanon Addendum LB-1
Purpose LB-1
Plan Process, Participation, and Adoption LB-1
Risk Assessment LB-2
Community Profile LB-2
Hazard Profile LB-8
Hazard Analysis LB-9
Hazard Characteristics LB-12

Mitigation Strategy LB-16
Plan Implementation and Maintenance LB-20
City of Lyons Addendum LY-1
Purpose LY-1
Plan Process, Participation, and Adoption LY-1
Risk Assessment LY-2
Community Profile LY-3
Hazard Profile LY-7
Hazard Analysis LY-8
Hazard Characteristics LY-10
Mitigation Strategy LY-14
Plan Implementation and Maintenance LY-19
Lyons Rural Fire District Addendum LFD-1
Purpose LFD-1
Plan Process, Participation, and Adoption LFD-1
Risk Assessment LFD-2
Community Profile LFD-2
Hazard Profile LFD-9
Hazard Analysis LFD-10
Hazard Characteristics LFD-13
Mitigation Strategy LFD-16
Plan Implementation and Maintenance LFD-19
City of Millersburg Addendum ML-1
Purpose ML-1
Plan Process, Participation, and Adoption ML-1
Risk Assessment ML-2
Community Profile ML-3
Hazard Profile ML-8
Hazard Analysis ML-9
Hazard Characteristics ML-12
Mitigation Strategy ML-17
Plan Implementation and Maintenance ML-21
City of Scio Addendum SC-1
Purpose SC-1
Plan Process, Participation, and Adoption SC-1
Risk Assessment SC-2
Community Profile SC-3
Hazard Profile SC-7
Hazard Analysis SC-9
Hazard Characteristics SC-11
Mitigation Strategy SC-15
Plan Implementation and Maintenance SC-20
City of Sodaville Addendum SV-1
Purpose SV-1
Plan Process, Participation, and Adoption SV-1
Risk Assessment SV-2
Community Profile SV-2

Hazard Profile SV-7
Hazard Analysis SV-8
Hazard Characteristics SV-11
Mitigation Strategy SV-14
Plan Implementation and Maintenance SV-18
City of Sweet Home Addendum SH-1
Purpose SH-1
Plan Process, Participation, and Adoption SH-1
Risk Assessment SH-2
Community Profile SH-3
Hazard Profile SH-11
Hazard Analysis SH-13
Hazard Characteristics SH-15
Mitigation Strategy SH-19
Plan Implementation and Maintenance SH-29
City of Tangent Addendum TG-1
Purpose TG-1
Plan Process, Participation, and Adoption TG-1
Risk Assessment TG-2
Community Profile TG-2
Hazard Profile TG-7
Hazard Analysis TG-8
Hazard Characteristics TG-10
Mitigation Strategy TG-14
Plan Implementation and Maintenance TG-20

LIST OF FIGURES AND TABLES

Figure GA-1. City of Gates Map GA-3
Table GA-1. City of Gates Hazard Profile GA-7
Table GA-2. City of Gates Critical Facilities GA-7
Table GA-3. OEM Hazard Analysis Methodology County Level Risk Scores GA-9
Table GA-4. Relative Risk of Natural Hazards in Gates GA-10
Figure GA-2. Special Flood Hazard Area in Gates GA-12
Table GA-5. Actions Removed from the Gates Addendum GA-14
Table GA-6. Ongoing, Short- and Long-Term Projects - Gates GA-16
Figure HL-1. City of Halsey Map HL-4
Table HL-1. City of Halsey Hazard Profile HL-8
Table HL-2. City of Halsey Critical Facilities HL-8
Table HL-3. OEM Hazard Analysis Methodology County Level Risk Scores HL-10
Table HL-4. Relative Risk of Natural Hazards in Halsey HL-11
Figure HL-2. Special Flood Hazard Area in Halsey HL-13
Table HL-5. Completed Actions - Halsey HL-15
Table HL-6. Actions Removed from the Halsey Addendum HL-16
Table HL-7. Ongoing, Short- and Long-Term Projects – Halsey HL-16
Figure HB-1. Harrisburg Comprehensive Plan Map HB-4
Table HB-1. City of Harrisburg Hazard Profile HB-8

Table HB-2. City of Harrisburg Critical Facilities HB-8
Table HB-3. OEM Hazard Analysis Methodology County Level Risk Scores HB-10
Table HB-4. Relative Risk of Natural Hazards in Harrisburg HB-11
Figure HB-2. Special Flood Hazard Area in Harrisburg HB-13
Table HB-5. Completed Actions - Harrisburg HB-15
Table HB-6. Actions Removed from the Harrisburg Addendum HB-17
Table HB-7. Ongoing, Short-, and Long-Term Projects - Harrisburg HB-18
Figure LB-1. Lebanon Comprehensive Plan Map LB-4
Table LB-1. City of Lebanon Hazard Profile LB-8
Table LB-2. City of Lebanon Critical Facilities LB-8
Table LB-3. OEM Hazard Analysis Methodology County Level Risk Scores LB-11
Table LB-4. Relative Risks of Natural Hazards in Lebanon LB-12
Figure LB-2. Special Flood Hazard Area in Lebanon LB-14
Table LB-5. Completed Actions - Lebanon LB-16
Table LB-6. Actions Removed from the Lebanon Addendum LB-17
Table LB-7. Ongoing, Short- and Long-Term Projects – Lebanon LB-18
Figure LY-1. City of Lyons Comprehensive Plan Map LY-4
Table LY-1. City of Lyons Hazard Profile LY-7
Table LY-2. City of Lyons Critical Facilities LY-7
Table LY-3. OEM Hazard Analysis Methodology County Level Risk Scores LY-9
Table LY-4. Relative Risks of Natural Hazards in Lyons LY-10
Figure LY-2. Special Flood Hazard Area in Lyons LY-11
Table LY-5. Completed Actions - Lyons LY-14
Table LY-6. Actions Removed from the Lyons Addendum LY-14
Table LY-7. Ongoing Actions, Short-, and Long-Term Projects - Lyons LY-16
Figure LFD-1. Lyons Rural Fire District Service Area LFD-4
Figure LFD-2. Lyons Rural Fire District Generalized Zoning Map LFD-5
Figure LFD-3. Oregon Bridges and Structurally Deficient Bridges in the Lyons RFD Area LFD-7
Table LFD-1. Lyons Fire District Hazard Profile within City of Lyons LFD-9
Table LFD-2. Lyons Fire District Critical facilities LFD-9
Table LFD-3. OEM Hazard Analysis Methodology County Level Risk Scores LFD-12
Table LFD-4. Relative Risks of Natural Hazards in the Lyons Rural Fire District LFD-13
Table LFD-5. Actions Removed from the Lyons Rural Fire District Addendum LFD-16
Table LFD-6. Ongoing, Short-, and Long-Term Projects – Lyons Rural Fire District LFD-17
Figure ML-1. Millersburg Comprehensive Plan Map ML-4
Table ML-1. City of Millersburg Hazard Profile ML-8
Table ML-2. City of Millersburg Critical Facilities ML-9
Table ML-3. OEM Hazard Analysis Methodology County Level Risk Scores ML-11
Table ML-4. Relative Risks of Natural Hazards in Millersburg ML-12
Figure ML-2. Special Flood Hazard Area in Millersburg ML-14
Table ML-5. Ongoing, Short- and Long-Term Projects – Millersburg ML-17
Figure SC-1. Scio Comprehensive Plan Map SC-4
Table SC-1. City of Scio Hazard Profile SC-8
Table SC-2. City of Scio Critical Facilities SC-8
Table SC-3. OEM Hazard Assessment Methodology County Level Risk Scores SC-10
Table SC-4. Relative Risk of Natural Hazards in Scio SC-11
Figure SC-2. Special Flood Hazard Area in Scio SC-13

Table SC-5. Actions removed from the Scio Addendum SC-15
Table SC-6. Ongoing, Short- and Long-Term Projects - Scio SC-17
Figure SV-1. City of Sodaville Map SV-4
Table SV-1. City of Sodaville Hazard Profile SV-7
Table SV-2. City of Sodaville Critical Facilities SV-7
Table SV-3. OEM Hazard Analysis Methodology County Level Risk Scores SV-9
Table SV-4. Relative Risk of Natural Hazards in Sodaville SV-10
Figure SV-2. Special Flood Hazard Area in the Sodaville Area SV-12
Table SV-5. Completed Actions - Sodaville SV-14
Table SV-6. Actions Removed from the Sodaville Addendum SV-14
Table SV-7. Ongoing, Short- and Long-term Projects - Sodaville SV-15
Figure SH-1. Sweet Home Comprehensive Plan Map SH-4
Table SH-1. Critical and Important Facilities in Sweet Home SH-4
Figure SH-2. State of Oregon Railroads 2022 ..... SH-7
Figure SH-3. Sweet Home Evacuation Map SH-8
Table SH-2. Existing Plans for Sweet Home SH-10
Table SH-3. City of Sweet Home Hazard Profile SH-12
Table SH-4. City of Sweet Home Critical Facilities SH-12
Table SH-5. OEM Hazard Analysis Methodology County Level Risk Scores SH-14
Table SH-6. Relative Ranking of Hazards for Sweet Home SH-15
Figure SH-4. Special Flood Hazard Area in Sweet Home SH-17
Table SH-7. Completed Actions – Sweet Home SH-19
Table SH-8. Actions Removed from the Sweet Home Addendum SH-20
Table SH-9. Ongoing, Short-, and Long-Term Projects – Sweet Home SH-23
Figure TG-1. Tangent Comprehensive Plan Map TG-4
Table TG-1. City of Tangent Hazard Profile TG-7
Table TG-2. Critical Facilities for Tangent TG-7
Table TG-3. OEM Hazard Analysis Methodology County Level Risk Scores TG-9
Table TG-4. Relative Risk of Natural Hazards in Tangent TG-10
Figure TG-2. Special Flood Hazard Area in Tangent TG-12
Table TG-5. Completed Actions - Tangent TG-14
Table TG-6. Actions Removed from the Tangent Addendum TG-15
Table TG-7. Ongoing, Short-, and Long-Term Projects - Tangent TG-17

CITY OF GATES ADDENDUM

Purpose

This document serves as the City of Gates's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by Gates to improve the resilience of the community. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the information contained in Volume I (Basic Plan) of this NHMP which serves as the plan foundation and Volume III which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

The City of Gates is on the border of Linn and Marion counties and participated in the Marion County MJ-NHMP during the 2017 update planning process.

During 2023 and 2024 Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities, including Gates, to update their addenda to the Linn County Natural Hazard Mitigation Plan, which expired May 23, 2023.

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the City of Gates will gain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Gates joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on April 19, 2024. On 2/7/2024, 4/3/2024, 7/17/2024, and 10/23/24, Gates City Administrator/Recorder, Traci Archer, and Public Works Superintendent, Greg Benthin, participated in meetings facilitated by DLCD Planner Katherine Daniel including to conduct a risk assessment exercise with other county jurisdictions that included a Hazard Vulnerability Assessment ranking. City staff including Gates Public Works Superintendent, Greg Benthin met again with DLCD on 8/5/2024 to update this addendum.

Gates staff promoted the NHMP survey and outreach efforts throughout the plan update by posting an information page on the city's website and by promoting the public input survey.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Gates Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Gates Addendum, are the result of a collaborative effort between residents, public agencies, non-profit organizations, the private sector, and regional organizations. Public officials, including Gates's City Administrator/Recorder and Public Works Superintendent, guided the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary sections, and Planning and Public Process (Appendix A).

The Gates City Administrator/Recorder is the designated convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The Gates City Administrator and the DLCD Project Manager revised the Gates Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the update process city staff and other participants provided additional information on potential funding sources, action item prioritization, and local resource and capacity restraints.

The City of Gates advisory group was comprised of the following individuals:

- Traci Archer, City Administrator/Recorder
- Greg Benthin, Public Works Superintendent

Gates staff used multiple approaches to engage the public including online informational resources and presenting information to the city council in public meetings. The advisory group was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the steering committee were provided an opportunity for comment via the plan review process (see Appendix A).

The convener for Gates will also remain active in the county's implementation and plan maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[1] This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards*.

Community Profile

This section provides information on city specific assets and populations. For additional information on the characteristics of Gates, in terms of geography, environment, population, demographics, employment and economics, and housing and transportation, see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan

[1] 44 CFR 201.6(2)(i)

for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

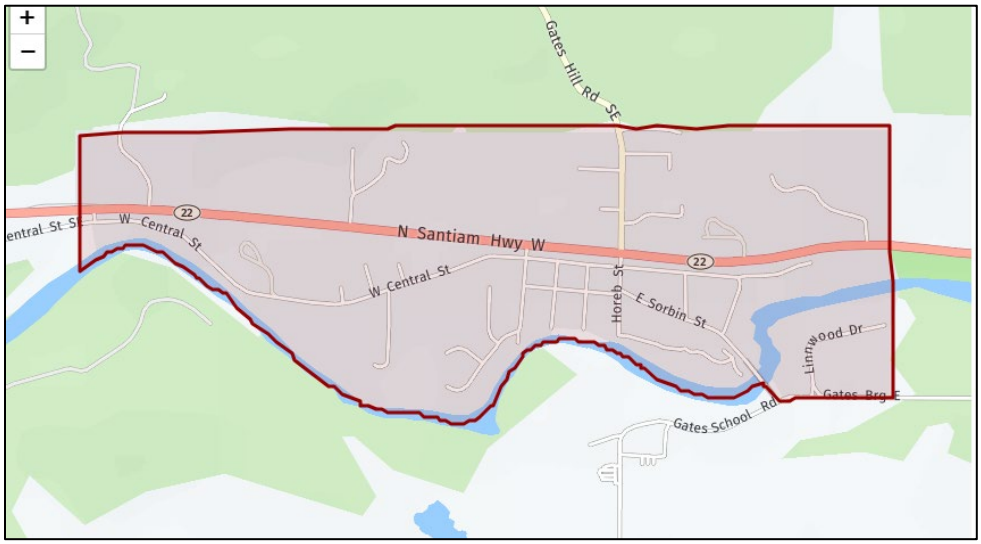
Gates is nestled along the North Santiam River 33 miles East of Salem on Highway 22. The City borders both Marion and Linn Counties. The Community of Gates formed in the mid to late 19th century, with schools established on both the north and south sides of the North Santiam River in the 1860s-70s. The town was platted in 1888 by the Gates family. The Oregon Pacific Railroad reached Gates in 1891, allowing for the community's growth as a timber service center. Gates was incorporated as a city in 1950.

Gates is the second largest city in the Santiam Canyon. Its elevation, at 945', creates a moderate climate. Summer temperatures hover between 51-76°F, while winter brings near freezing temperatures usually ranging from 32-44°F. Gates receives approximately 64 inches of rain and 10 inches of snow each year. The city's topography is relatively flat but does possess terrain attributed to the North Santiam River. Outside of city limits, steep slopes surround the city on the north and south sides.

The Population Research Center at Portland State University (PSU) estimates Gates's 2023 population at 552. This represents an increase from a population of 471 in 2010 (8.5%). For more demographic information, refer to Appendix B.

Gates benefits from its location along Highway 22, a major east-to-west transportation route connecting Salem to Bend. Existing business types include hospitality, restaurants, and service stations. Most residents in the community still rely on resource extraction employment which includes agriculture, forestry, fishing, or hunting. Gates economy is limited because of its small population size and lack of infrastructure capacity, which has limited development that does not front on Highway 22. Median household income in Gates in 2022 was $60,625, in the middle third of cities in Linn County. For more economic information, refer to Appendix B: Community Profile.

Figure GA-1. City of Gates Map



Critical and Important Facilities

Gates's critical and important facilities include the following:

- City Hall and Public Works Shop, 101 Sorbin Ave W
- Gates RFPD, 140 E. Sorbin Ave
- Water Treatment Plant, 125 River View St

Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information. No lifeline facilities in Gates were evaluated by DOGAMI.

Transportation

Oregon Route 22 is the major transportation route for auto, public transit, and emergency vehicle access throughout the Santiam Canyon. Highway 22 spans about 32 miles west, connecting Gates to Salem and the remainder of the Willamette Valley. To the east, the highway connects to Mill City, Gates, Detroit, Idanha, and ends at the Santiam Pass interchange. An estimated 4,930 vehicles per day travel the canyon near Gates, with peak volumes of between 6,000 – 8,000 during the busiest months of the summer.

Road	Owner	Notes
OR-22	ODOT	East/west route

Structure Name	Year Built	Structural Condition
East Sorbin Street Bridge	1994	Good

The Cherriots Canyon Connector is the only existing public transit service in the entire Santiam Canyon. This route has three total roundtrips with buses running approximately every five hours.

In case of a major Oregon Route 22 closure, Gates residents will have to rely on alternate routes to reach supplies or safety in the Willamette Valley. Lyons-Mill City Drive serves as an additional evacuation route.

Energy

Gates receives energy and utility services from Pacific Power. There is one main power line that runs south of Gates, connecting to the main substation in Lyons. Gas stations with fuel storage exist near Gates within Mill City, but their below ground tanks cannot be pumped without electricity. Businesses, including Ferris & Frank Lumber, also possess fuel storage that could be shared with Mill City and Gates.

Backup power in Gates currently includes two propane generators and one diesel generator. The Water Treatment Plant will soon have solar panels installed and a backup generator for emergencies.

Water/Wastewater

The City of Gates water system consists of intake lines, water treatment facility, two storage tanks, and distribution lines. Two intake lines are located in the North Santiam River and the City also has an intake wet well. The City has a membrane water treatment facility located on the North Santiam River at 125 River View Street. The facility has a diesel generator with a 400-gallon storage tank. There are two storage tanks that total 500,000 gallons (150,000 and 350,000 tanks). This above ground storage can last the city and its residents for approximately 4-5 days. The City replaced its main water lines in 2015, 10% of the water distributed is being lost through leaky pipes. The City implements leak detection methods when it finds that excess water use is occurring.

Gates continues to invest in the water system. Waterlines have been upgraded and in October 2016 a study was conducted on the water system to assess the vulnerable infrastructure. The City also maintains a Water Management Conservation Plan that is updated by the Oregon Water Resource Department. It was last updated in 2015. The City intends to expand its outreach on this plan. Currently information about conservation methods is sent to all water account holders yearly.

There are currently no alternative water sources available. If power is lost, propane powered generators are available for fire lines, and submersible pumps are available for municipal water.

Gates does not have a municipal wastewater treatment system. Residents and commercial businesses utilize individual septic tanks. Many residential septic tanks have never been replaced and could be over 50 years old. City staff believe that many of these tanks may be leaching biohazardous waste into the surrounding soil.

A feasibility study has been completed to assess a regional wastewater treatment facility. The system is being designed to serve Gates and Mill City.

Emergency Services

Gates does not receive any police support. Emergency service support relies heavily on the Gates Rural Fire Protection District and the local Marion County CERT team.

Gates is home to the bus storage location for the Santiam School District. One of the City's mitigation actions is to create an agreement with First Student, which runs the school district's bus service, to allow the city to use district buses during and after hazard events.

Community Assets, Vulnerable Populations, and Plans and Policies

Cultural/Historical Resources

No major buildings of historical significance are located in Gates.

Functional and Access Needs of Vulnerable Populations

Almost half of the residents of Gates live in households with individuals 65 years or older. A higher proportion of the population of Gates as compared to Linn County are people 65 years or older living alone. Preparing to reduce risks for older people involves attention to communication style and content as well as preparation for mobility and medical needs.

Gates is also one of the cities with a higher proportion of single parent households than the county averages.

In terms of housing stock, Gates has a high percentage of mobile homes and other mobile structures used as homes, at 42%. This could be related to the 2020 Labor Day wildfires that devastated the area. For more details regarding demographics, economics, and housing stock in Gates, see Appendix B: Community Profile.

Plans and Policies

Gates's acknowledged comprehensive plan is the Gates Comprehensive Plan. The Oregon Land Conservation and Development Commission first acknowledged the plan in 1977. The City last completed a major update of the plan in 2009. The City implements the plan through the Gates zoning ordinance. Gates currently has the following plans that relate to natural hazard mitigation available online or by request:

- Comprehensive Plan, (1977, last amended July 2024)
- Zoning Ordinance, including Flood Damage Prevention chapter (last amended 2024)
- Water Management Conservation Plan (2015)
- Water Master Plan, April 2012
- Gates, Oregon Community Vision & Strategic Plan (Draft), December 2021

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's mitigation strategy. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city has identified mitigations actions that will help to increase Gates' overall mitigation capability.

Hazard Profile

The DOGAMI Multi-Hazard Risk Assessment (MHRA) report analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the follow tables. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table GA-1. City of Gates Hazard Profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Gates		493	326		3	70,923,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	3	0.5%	6	0	756,492	1.1%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0%	4	0	2,366,249	3.3%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	33	6.6%	27	0	6,929,000	9.8%
Wildfire	High and Moderate Risk	56	11%	46	0	11,012,000	15%
Volcanic Lahar	1% Annual Chance	323	65%	216	1	49,139,000	69%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Source: DOGAMI Multi-Hazard Risk Report, 2024

Table GA-2. City of Gates Critical Facilities[2]

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Volcanic Lahar - 1% Annual Chance
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Gates City Hall & Public Works Shop	-	-	-	-	-	-	-
Water Treatment Plant	-	-	-	-	-	-	X
Gates RFPD	-	-	-	-	-	-	-

Source: DOGAMI Multi-Hazard Risk Report, 2024

[2] Gates City Hall was not analyzed by DOGAMI for exposure or loss estimates

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the steering committee representatives first updated the description, type, location, and extent of each hazard. Next, they updated the Hazard Analysis Methodology based on each hazard's potential impact on the county as a whole. The results of that exercise are provided in Table GA-3.

In this analysis, severity ratings and weight factors are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2, Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

This method provides the jurisdictions with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The City of Gates representatives refined the risk assessment with guidance provided by the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table GA-4, below, represents the variation in total risk to the natural hazards as experienced in the City of Gates compared to the county level ranking completed by the Steering Committee.

Winter Storm, which was revised in 2024 to include Ice Storms, retains the top ranking among all hazards for the county and the city. Flood is of less importance in Gates due to the shape of the channel and low likelihood that the river would rise above its banks.

Wildfire was also of less concern than in the county due to the devastating nature of the 2020 Beachie Creek wildfire that removed much of the fuel that would burn in a wildfire. The City representatives noted the impact of the loss of the forest around the city in terms of stormwater runoff. The loss of the trees has changed the ability of the soil to absorb water, which can increase risk of debris flows.

Windstorm/Tornado, Volcano, and Landslide/Avalanche were hazards of greater concern to the City of Gates than to the county as a whole. The loss of the forest has changed the way air moves down the mountains and across the city. Due to the topography surrounding the City of Gates, the probability of Landslide, or debris flows, is greater than in the county as a whole. Gates is in the potential path of lahar should Mt. Jefferson erupt.

The Dam Failure hazard in this plan relates to non-federal dams. The two federal dams upstream from the city are of concern but will not be addressed in this plan.

Table GA-3. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table GA-4. Relative Risk of Natural Hazards in Gates

Hazard	County	Gates
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	↓
Drought	169.0	same
Earthquake (Cascadia)	160.7	same
Wildfire	158.9	↓
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	n/a
Windstorm/Tornado	116.5	↑
Volcano	109.0	↑
Landslide and Avalanche	106.4	↑

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Gates. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Gates Hazard Profile and Critical Facilities tables (GA-1 and GA-2) included above, this section identifies vulnerabilities specific to Gates, recent localized hazard events and impacts, and illustrates the basis for the city's HVA scores.

Dam Failure

Events: No events since 2017

Vulnerability and Impacts: Although Gates is downstream from two large federal dams, the city is not at risk from any dams that would be assisted by the High Hazard Potential Dam program.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018 and 2021-2023.

Vulnerability and Impacts: The City's water supply, described above, may be susceptible to impacts from drought. The City maintains a Water Management Conservation Plan and annually sends information about conservation methods all water account holders. Drought can also impact tree health throughout the community, increasing the vulnerability of trees

to other natural hazards, such as windstorms and winter storms, and potentially decreasing the canopy which provides cooling benefits to mitigate extreme heat.

Earthquake

Events: No events since 2017.

Vulnerability and Impacts: Older homes that have not been seismically retrofitted. Water distribution lines may be at risk from earthquake impacts.

Extreme Heat

Events: 2021 heat dome affected residents of Gates.

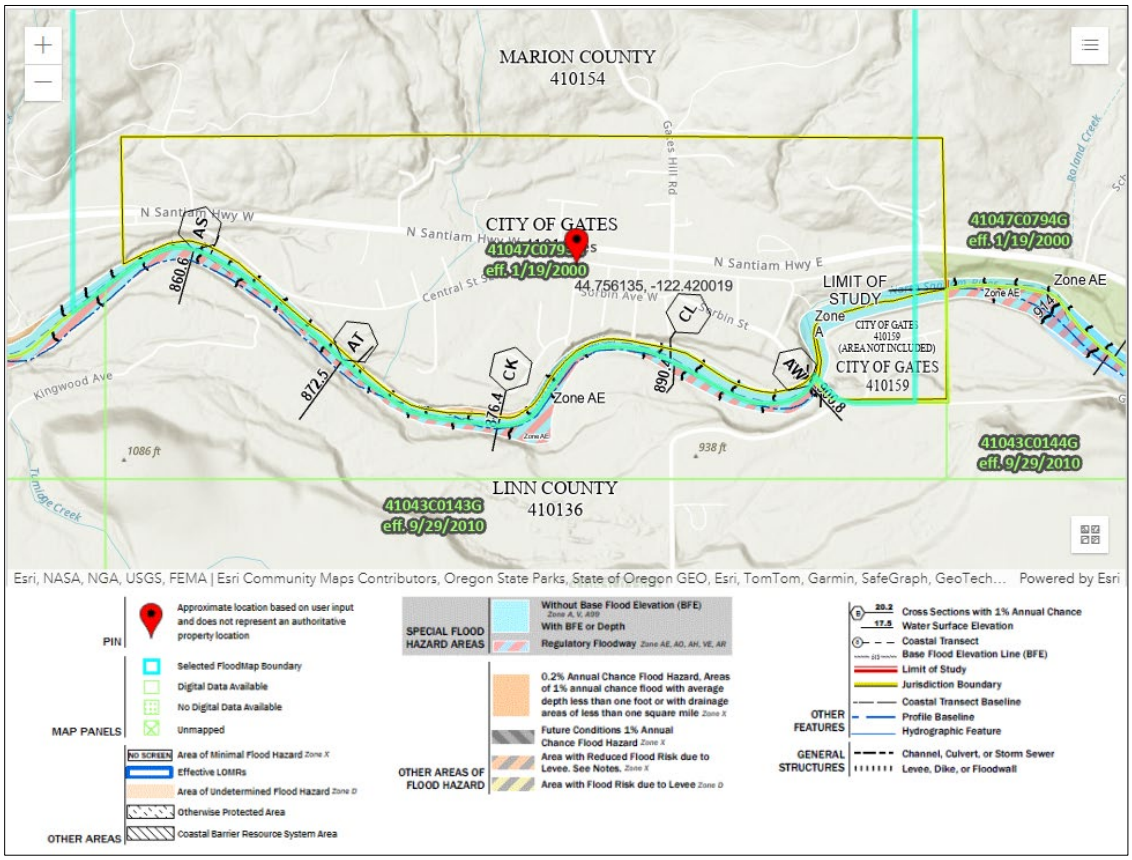
Vulnerability and Impacts: Few homes have air conditioning. There is no community cooling center in Gates. Neighbors depend on neighbors for assistance during such events.

Flood

Events: No events since 2017.

Vulnerability and Impacts: Due to its location along the North Santiam River, Gates is susceptible to flooding in areas mapped in the Special Flood Hazard Areas, shown in the following figure. However, no buildings or critical facilities were identified by DOGAMI as being exposed. In areas with localized flooding, the City collaborates with the RFPD to provide bags and sand to homes near streams. Related to potential flooding, there are 27 buildings identified by DOGAMI as being exposed to channel migration, which long-term may increase the flood risk in Gates.

Figure GA-2. Special Flood Hazard Area in Gates



Source: [FEMA Flood Map Service Center | Search By Address]

Landslide/Avalanche

Events: None.

Vulnerability and Impacts: Post-wildfire debris flows are of concern in steeply sloped areas outside of the city.

Smoke/Poor Air Quality

Events: Annually smoke from field burning in the valley migrates toward Gates. The county allows field burning when the wind is blowing from west to east. Gates also experiences smoke from wildfires outside of the county due to the shape of the canyon in which the city sits.

Vulnerability and Impacts: Few homes have air filters. There is no community clean air refuge in Gates. Neighbors depend on neighbors for assistance during such events.

Volcano

Events: None.

Vulnerability and Impacts: The city is potentially quite vulnerable to this hazard but would probably have some warning prior to eruption from Mt. Jefferson. The City's Public Works Shop was identified by DOGAMI as being exposed to volcanic lahar, 1% annual chance.

Wildfire

Events: 2020 Beachie Creek wildfire burned many buildings in Gates and forced a middle of the night evacuation.

Vulnerability and Impacts: City residents were dependent on county alerts for notices and on volunteer fire fighters for initial response to a very fast-moving fire. Evacuation routes were limited to a single road, Highway 22. Loss of power also resulted in vulnerability and loss of communications.

Winter Storm/Ice Storm

Events: Several winter storms and a notable ice storm in February 2021 (DR-4599) and January 2024 (DR-4768).

Vulnerability and Impacts: Trees remaining in Gates following the 2020 wildfire were toppled by heavy ice loads. Overhead power lines were brought down by heavy ice loads.

Windstorm/Tornado

Events: September 2020 wind event precipitated the rapid spread of the Beachie Creek wildfire among others. Wind during an ice period in 2023 also resulted in the downing of large trees in the city.

Vulnerability and Impacts: Power lines and trees are vulnerable, resulting in needing to aid residents and potentially impacting the transportation network.

Mitigation Strategy

During the 2023-2024 Linn County and Gates NHMP update process, the DLCD planner and Gates representatives assessed the mitigation strategy actions within the 2017 Gates Addendum. Together they revised and updated that list of actions to reflect the revised risk assessment for the city.

Table GA-5. Actions Removed from the Gates Addendum

2017 Action Item	Proposed Action Title	Coordinating Organization	Partner Organizations	2017 Timeline	2024 Status	Notes
Earthquake #1	Promote Great Oregon Shakeout Awareness month in October. Participate in activities for schools, business, and industry. Participating with the Mid-Willamette Emergency Communications Collective on initiatives that are focused on household preparedness.	Marion County Emergency Management	Public Works, Safety Committee, Marion County Risk, Red Cross, OEM and Media	Ongoing every October	Remove	Lead organization is the County
Earthquake #2	Collaborate with GROW EDC to develop relevant public-private partnerships with businesses that can contribute to response and recovery.	Gates, Marion County Emergency Management	GROW EDC	Ongoing	Remove	GROW no longer exists
Multi-Hazard #1	Develop an Energy Assurance Plan	Gates, Marion County Emergency Management	Department of Energy, Whole Community	Ongoing revisions	Remove	This is beyond the city's purview
Multi-Hazard #2	Conduct an assessment of the short- and long-term needs for sheltering access and functional needs populations for all hazards.	Gates, Marion County Emergency Management	Marion County Public Health, Red Cross, Cities, NGO's, Oregon Public Health	Short Term	Remove	City does not own property that could serve as a shelter.

2017 Action Item	Proposed Action Title	Coordinating Organization	Partner Organizations	2017 Timeline	2024 Status	Notes
Multi-Hazard #6	Purchase and store emergency rescue rafts for EMS to allow for the use of the North Santiam River as an emergency transportation option.	Gates, Marion County Emergency Management	RFPD	Short Term	Remove	This action isn't practical
Multi-Hazard #7	Continue to train and expand Gates CERT team.	Marion County Emergency Management, Gates	CERT, Whole Community	Short Term	Remove	RFPD does this
Multi-Hazard #9	Expand auxiliary radio capabilities by developing a team of HAM Radio operators for EMS and interested public.	Marion County Emergency Management, Gates	ARES, CERT, Private partners, Whole Community	Short Term	Remove	This action is not within the city's capacity
Drought #1	Monitor economic impacts on recreation, tourism and agriculture communities.	Gates, Marion County Emergency Management	Marion Co. Community Services	Long Term	Remove	Not relevant to Gates
Flood #2	Create partnerships and strategic plans with North Santiam Watershed Council to explore alternative water supply sources.	Marion County Environmental Services, Gates	Marion County Parks, Oregon Department of Fish and Wildlife	Long Term	Remove	Not relevant to Flood
Multi-Hazard #10	Conduct road improvements on Gates Hill Road and Hudel Road as identified in the CWPP.	RFPD, Gates, Marion County Public Works	Marion County Emergency Management	Long Term	Remove	These are not city roads
Multi-Hazard #12	Gather community support for the installation of resilient fiber communication infrastructure throughout the community.	Gates	Marion Co. Community Services Department/	Long Term	Remove	This is not within the purview of the city

2017 Action Item	Proposed Action Title	Coordinating Organization	Partner Organizations	2017 Timeline	2024 Status	Notes
			Board of Commissioners			
Wildfire #1	Collaborate with Detroit Ranger District, ODF, and BLM to conduct fuel hazard reduction along the Wildland Urban interface.	ODF, BLM, Detroit Ranger District	Marion County Emergency Management	Long Term	Remove	Not relevant given the current situation in Gates post 2020 wildfire

Table GA-6. Ongoing, Short- and Long-Term Projects – Gates

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Organization	Partner Organizations	2024 Status	2024 Timeline*	Potential Funding Sources	Notes
Multi-Hazard 1	Develop a MOU with the Santiam School District to utilize facilities for sheltering residents.	Gates, Marion County Emergency Management	Santiam School District, RFPD	Retain	Short Term	Within current capacity	
Multi-Hazard 2	Develop a MOU with First Student to utilize buses during/after hazard events	Gates, Marion County Emergency Management	First Student	Retain	Short Term	Within current capacity	
Multi-Hazard 3	Develop a MOU with Frank & Ferris Lumber to share fuel resources after a hazard event.	Gates, Marion County Emergency Management	Franks Lumber, RFPD	Retain	Short Term	Within current capacity	
Multi-Hazard 4	Continue to provide community education program - such as an on all hazards using flyers and the city website to inform the community outreach forum for students and residents.	Marion County Emergency Management, Gates	Public Works, Whole Community	Retain	Ongoing	Within current capacity	

Hazard Action Item	Action Title	Coordinating Organization	Partner Organizations	2024 Status	2024 Timeline*	Potential Funding Sources	Notes
Multi-Hazard 5	Collaborate with North Santiam Sewer Authority and Marion County to establish a more resilient regional sewer system.	Marion County Community Services Department/ Emergency Management, City of Gates, Public Works	Marion County Emergency Management	Retain	Long Term	Within current capacity	
Drought 1	Improve community understanding of water usage and opportunities to increase efficiencies.	NSWC, Gates	North Santiam Watershed DCP Partners	Retain and revise	Ongoing	Within current capacity	WMCP was completed.
Flood 1	Conduct leak detection surveys when water use is elevated.	Marion County Environmental Services, City of Gates Public Works	Oregon Department of Fish and Wildlife	Retain and revise	Ongoing	Within current capacity	Surveys established.
Landslide 1	Integrate new DOGAMI landslide hazard and debris flow hazard information into land use zoning/development codes.	City of Gates, Mayor and City Council	Environmental Services, Engineering, ODOT, DLCD	Retain	Long Term	DLCD Technical Assistance Grant	

Plan Implementation and Maintenance

The City Council is responsible for adopting the Linn County MJ-NHMP including the City of Gates Addendum to the Linn County MJ-NHMP. The City Administrator is responsible for coordinating implementation and maintenance of the Gates Addendum to the Linn County MJ-NHMP and will participate in the Linn County NHMP implementation and maintenance meetings. The Gates representative will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of Gates's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. Gates is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, Gates will also review and update its addendum. The Gates convener will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Gates's convener determine what components of the mitigation plan need updating.

CITY OF HALSEY ADDENDUM

Purpose

This document serves as the City of Halsey's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by the City of Halsey to improve the resilience of the community. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the information contained in Volume I (Basic Plan) of this NHMP which serves as the plan foundation and Volume III (Appendices) which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

Prior to 2017, Halsey had not participated in a natural hazard mitigation planning process. This is the City's first update.

During 2023 and 2024 Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities, including Halsey, to update their addenda to the Linn County Multi-Jurisdictional Natural Hazard Mitigation Plan, which expired May 23, 2023.

By developing this addendum to the Linn County NHMP, locally adopting it, and having it approved by FEMA, the City of Halsey will gain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Halsey joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on 12/20/2024. On 2/7/24, 3/13/24, and 7/17/24 Halsey City Administrator, Briana Parra, and Mayor Jerry Lachenbruch participated in meetings facilitated by DLCD including to conduct a risk assessment exercise with other county jurisdictions that included a Hazard Vulnerability Assessment ranking. City staff met again with DLCD on 8/1/24 and 12/2/24 to update this addendum.

Halsey staff promoted the NHMP survey and outreach efforts throughout the plan update, by posting a news story with a link to the Linn County Natural Hazard Mitigation Plan webpage on the City of Halsey website.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the City of Halsey Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Halsey addendum, are the result of a collaborative effort between citizens, public agencies, non-profit organizations, the private sector, and regional organizations. Public officials, including Halsey's Mayor, City Administrator, and Public Works Manager, guided the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary sections, and Planning and Public Process (Appendix A).

The Halsey City Administrator is the designated convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The City Administrator and the DLCD Project Manager revised the Halsey Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the update process city staff and other participants provided additional information on potential funding sources, action item prioritization, and local resource and capacity restraints.

The City of Halsey advisory group was comprised of the following individuals:

- Briana Parra, City Administrator
- Mayor Jerry Lachenbruch
- Andy Ridinger, Public Works Manager

Halsey engaged the public through conversations with local stakeholders throughout the process including the local fire district, school district, and City Council. The advisory group was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the advisory group were provided an opportunity for comment via the plan review process (see Appendix A for more information).

The convener for Halsey will also remain active in the county's implementation and plan maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards." This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards.*

Community Profile

This section provides information on city specific assets and populations. For additional information on the characteristics of Halsey, in terms of geography, environment, population, demographics, employment and economics, housing, and transportation, see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

The City of Halsey is located in Linn County, approximately 20 miles southeast of Corvallis and 30 miles north of Eugene. Halsey was founded in 1872 and was legally incorporated in 1876. It occupies an area of 0.56 square miles (358.4 acres). The average annual temperature is 55°F, with summer temperatures reaching the mid-80s and an annual low of 35°F. The average annual rainfall is about 42 inches. Average monthly precipitation varies from about 6 inches in January to about 0.5 inches in July. Average annual snowfall is about 6 inches, although many years have no measurable snowfalls.

Due to its location in the Willamette Valley, Halsey's topography is relatively flat. The Cascade Mountains begin approximately 20 miles to the east. Major rivers include the Willamette to the west and the South Santiam to the east. In general, Halsey is free from riverine flooding, however, flooding does occur from high ground water and ineffective storm drainage. Additionally, flooding on portions of Little Muddy Creek and Spoon Creek have the potential to sever major transportation lines both to the east and west. For example, in 2012 high water closed Highway 228 due east of Halsey for several days.

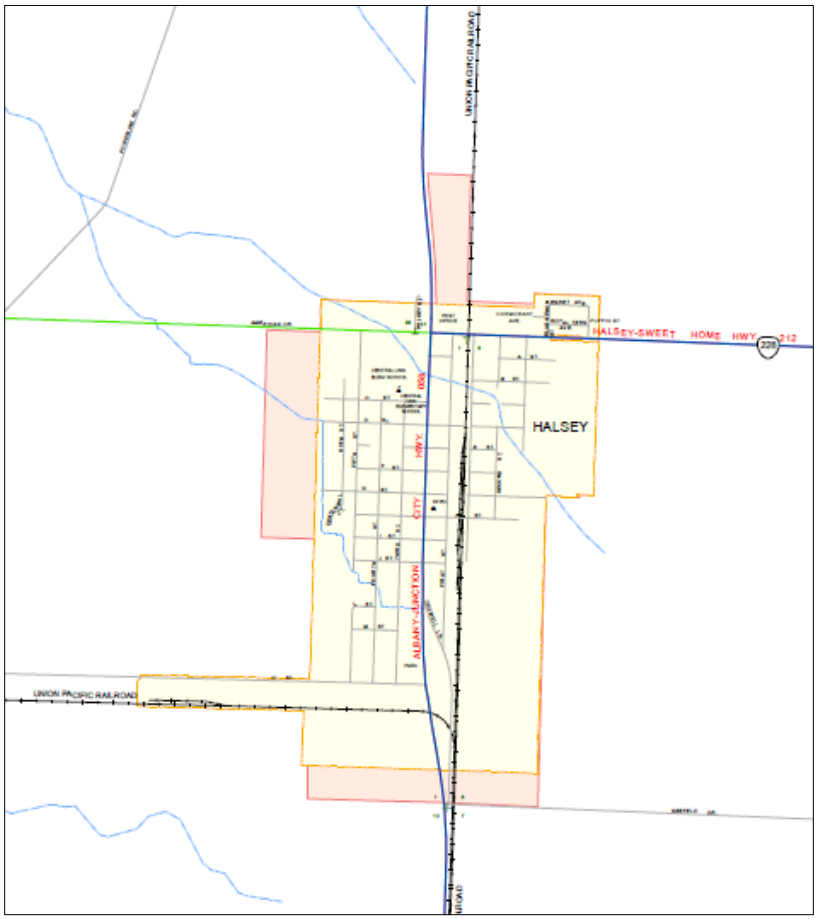
The Population Research Center at Portland State University lists Halsey's 2023 population at 952. This represents a minimal increase from 2015. For more demographic information, refer to Appendix B: Community Profile.

Historically, Halsey was an agricultural and railroad community. Although agriculture is still an important industry in the surrounding areas, more than three-quarters of the labor force in Halsey were employed in services, wholesale trade, and public administration, and retail trade.[3] Like many small communities in Oregon, a large portion of Halsey's resident commute outside of the city limits for work, primarily to larger nearby urban centers such as Corvallis/Albany and Eugene/Springfield.

The demographic data reflects a split in economic means. Median household income in Halsey in both 2015 and 2023 was above the median household income for the county. However, the percentage of the population under age 18 was as high in Halsey as in the county at 13.5 %. For more economic information, refer to Appendix B: Community Profile.

[3] Business Oregon – Oregon Prospector. Total Employees by Major SIC (2017) for Halsey, OR. http://oregon.zoomprospector.com/

Figure HL-1. City of Halsey Map



Source: Oregon Department of Transportation, 2023, https://www.oregon.gov/ODOT/Data/Documents/City_Halsey.pdf

Critical and Important Facilities

Critical and important facilities in Halsey include the following:

- Halsey-Shedd Fire District, Station 51, 740 W 2nd St, Halsey, OR 97348
- Public Works Shops,[4] 1133 W 4th St, Halsey, OR 97348
- City Hall and Community Center, 100 Halsey St, Halsey, OR 97348
- Halsey Public Library, 773 W 1st St, Halsey, OR 97348
- Central Linn Elementary School, 239 W 2nd St, Halsey, OR 97348

Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information. Lifeline facilities in Halsey evaluated by DOGAMI include a

[4] Also houses water tanks, water treatment facility, and heavy equipment

church and a business that maintains a supply of fuel, which were not found to be vulnerable.

Transportation

Highway 99E is the major road within Halsey and provides north/south transportation access throughout the city. State Highway 228 provides the major east/west transportation route through the city. Both of these roads lie within the 100-year flood plain directly to the north, south, east, and west of the city center. It is likely that flood events would cause isolation from other population centers in the county such as Albany, as well as the I-5 corridor. The loss of these transportation routes has the potential to block access for emergency services and police support. Smaller county roads may provide transportation redundancies for Halsey residents to the south, however high-water events on Little Muddy Creek and Spoon Creek could flood those roads periodically.

Road	Owner	Notes
OR-99E	ODOT	North/South route within the city
OR-228	ODOT	East/West route within the city
Railroad	Union Pacific	Operated by Union Pacific and Amtrak

Energy

The City maintains a generator for the wastewater lift pumps as well as for the lagoon in case of emergency power shut offs. The City also maintains a generator for the water treatment plant for continued water supply during power outages. Pacific Power and Northwest Natural Gas are the energy providers serving the Halsey

Water/Wastewater/Stormwater

Halsey receives its primary water supply from two main wells which flow to a gravity fed water treatment facility. The facility contains two steel storage reservoirs capable of holding 750,000 gallons. The City is in the process of replacing one well for drought resiliency. The older of the two city wells failed in 2022, and the remaining well is nearing the end of its projected useful life.

Droughts are a generally rare occurrence in Halsey because the aquifer residents rely on for well water and agricultural uses has always had sufficient capacity to serve the population's needs. However, the advisory group acknowledges that in the future, increased climate variability and climate change may affect water availability. This will be an issue the City continues to monitor.

The Halsey Water Management and Conservation Plan (WMCP) contains several actions related to drought impacts, including initiatives to reduce overall residential water use.[5] The WMCP also includes provisions for water curtailment in cases of drought.[6]

Halsey is updating the Wastewater Master Plan. The wastewater produced by the City is pumped to a series of three lagoons, where it is treated. In 2009, the water treatment

[5] Oregon Association of Water Utilities. "Water Management and Conservation Plan, City of Halsey." January 2022.
[6] Ibid.

facility pump lifts were replaced. City staff identified that the lift station in the city is key to getting septage to the treatment facility.

A large portion of the water and sewer pipe network is reaching replacement age as most was established around 1969. The City has received approval to replace sewer pipes and secured funding to address Inflow and Infiltration (I&I) concerns which reduce the effectiveness of the system. Halsey will implement the I&I project in 2025.

The Stormwater Master Plan is new since the last NHMP update.

Emergency Services

The Halsey-Shedd Fire District (HSRFD) provides local emergency services, providing response to fire, health related emergencies, and partnering with the City of Halsey to manage emergency response supplies to the community. Halsey has been selected as a host site for an emergency supply Conex box through the Oregon Chinese Coalition and funded by Oregon Department of Human Services under the Resilience Hub grant. HSRFD will manage supply distribution in emergency events and City of Halsey will provide a secure location for storage.

Community Assets, Vulnerable Populations, and Plans and Policies

Cultural/Historical Resources

The Halsey Public Library and the former Halsey State Bank Building, which now serves as the Post Office, are both significant historical resources identified in the Halsey Register of Historic Resources. The former Halsey Christian Church, the Halsey Methodist Church, and the former Cross and White Hardware Store, along with the Halsey School and several residences are listed in the register.

Functional and Access Needs of Vulnerable Populations

The percentage of people 15-44 years old is the greatest in Halsey compared to the other cities in Linn County at just over 44%, with a median age of 37.2 as compared to the county median age of 40.0. The City of Halsey has among the highest median household incomes in Linn County in 2022.

It is among the cities with greatest number of children under 18 years old per hundred people potentially within the workforce as measured by the child dependency ratio. Halsey is among the cities in Linn County with a proportion of single parent households higher than the county average. US Census data show that poverty for children in Halsey increased to approximately the county average between 2015 and 2022. For more details on the demographics of Halsey, see Appendix B: Community Profile.

Plans and Policies

The Halsey Comprehensive Plan[7] was first acknowledged by the Oregon Land Conservation and Development Commission in 1980. The city last amended the plan in 1990. Halsey last updated Section 8 of its comprehensive plan, which concerns Statewide Planning Goal 7,

[7] KMBT_C554e-20160204093400 (revize.com)

Natural Hazards, in 1980. The City implements the plan through the City of Halsey Development Code, which was last revised in 2019.

Halsey currently has the following plans that relate to natural hazard mitigation, which can be found on the City's website or by contacting the City Recorder:

- Halsey Comprehensive Plan (1980, amended January, 1990)
- Community Development Code (May, 2019)
    - Chapter 3.7 Floodplain Standards
- Water Management and Conservation Plan (January 2022)
- Stormwater Master Plan (November 2022)
- Wastewater Master Plan (projected completion 2025)

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's mitigation strategy. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city has identified mitigations actions that will help to increase Halsey's overall mitigation capability.

Hazard Profile

The DOGAMI Multi-hazard Risk Assessment analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the follow tables. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table HL-1. City of Halsey Hazard Profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Halsey		955	602		5	182,922,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	26	2.7%	79	1	19,448,832	11%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0%	2	0	1,553,929	0.8%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	21	2.2%	15	0	2,534,000	1.4%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Source: DOGAMI Multi-Hazard Risk Report, 2024

Table HL-2. City of Halsey Critical Facilities

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Central Linn Elementary School*	-	-	-	-	-
Halsey City Hall and Community Center	-	X	-	-	-
Halsey Public Library	-	-	-	-	-
Halsey Public Works**	-	-	-	-	-
Halsey-Shedd RFPD - Station 51*	-	-	-	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.

**Also houses water tanks, water treatment facility, and heavy equipment

Source: DOGAMI Multi-Hazard Risk Report, 2024

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the Halsey representatives

first updated the description, type, location, and extent of each hazard. Next, they updated the Hazard Analysis Methodology based on each hazard's potential impact on the county as a whole. The results of that exercise are provided in Table HL-3.

In this analysis, severity ratings, and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2, Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

This method can provide a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The City of Halsey representatives refined the risk assessment with guidance provided by the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table HL-4, below, represents the variation in total risk to the natural hazards as experienced in Halsey compared to the county level ranking completed by the Steering Committee.

Winter Storm, which was revised in 2024 to include Ice Storms, retains the top-ranking hazard for the county and the city. The impact of the January 2024 ice storm (DR-4768) on trees in Halsey has had an impact on the city in terms of tree maintenance and removal. Extreme Heat, Smoke and Poor Air Quality, both newly identified hazards in this update, along with Windstorms rank most highly for the City of Halsey staff. The impact of windstorms on tree mortality was an impact identified by city staff.

Wildfire is a greater threat to the City than it was ranked by the county, specifically a greater risk to the city than Earthquake. Drought has become a greater concern for the City of Halsey than in the past. The county's ranking of Drought increased since the last NHMP risk assessment exercise was conducted in 2016.

The city does not consider Volcano, Landslide, or Dam Failure to be hazards that require mitigation action by the city and will not identify mitigation actions for those hazards.

Table HL-3. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table HL-4. Relative Risk of Natural Hazards in Halsey

HAZARD	County	Halsey
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	↓
Drought	169.0	↑
Earthquake (Cascadia)	160.7	↑
Wildfire	158.9	same
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	n/a
Windstorm/Tornado	116.5	↑
Volcano	109.0	n/a
Landslide and Avalanche	106.4	n/a

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Halsey. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Halsey Hazard Profile and Critical Facilities tables (HL-1 and HL-2) included above, this section identifies vulnerabilities specific to Gates, recent localized hazard events and impacts, and illustrates the basis for the city's HVA scores.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018, and 2021-2023.

Vulnerability and Impacts: Droughts are generally a rare occurrence in Halsey because the aquifer residents rely on for well water and agricultural uses has always had sufficient capacity to serve the population's needs. The two main wells which the City receives its primary water supply from flow to a gravity fed water treatment facility. The City is in the

process of replacing one well for drought resiliency, and the other well is nearing the end of its projected useful life. The City is aware that increased climate variability and climate change may affect water availability and will continue to track this issue.

Earthquake

Events: None.

Vulnerability and Impacts: City staff noted the old grain elevator, located at 610 W. 1st Street, which posed a risk to buildings and people should it collapse. The grain silo was demolished in October 2024.

DOGAMI's analysis identified Halsey City Hall and Community Center as being vulnerable to a CSZ 9.0 earthquake. In addition to building damages, utility (electric power, water, wastewater, natural gas) and transportation systems (bridges, pipelines) are also likely to experience significant damage. The City's reservoirs are potentially vulnerable to earthquake. However, due to a lack of mechanical infrastructure, the city's wastewater treatment facilities may suffer reduced damage.

Utility systems will be significantly damaged, including damaged buildings and damage to utility infrastructure, including equipment at high voltage substations (especially 230 kV or higher which are more vulnerable than lower voltage substations). Buried pipe systems will suffer extensive damage with approximately one break per mile in soft soil areas. There would be much lower rate of pipe breaks in other areas. Restoration of utility services will require substantial mutual aid from utilities outside of the affected area.[8]

Extreme Heat

Events: Excessive heat and high heat events in 2017, 2021, and 2022.

Vulnerability and Impacts: Older housing stock may represent issues of older insulation or none and low likelihood of air conditioning available in the home.

The City is working on establishing more tree canopy within the city. The City uses social media to provide information to the public about how to protect themselves and promotes use of the city community center to the public during extreme heat events.

Flood

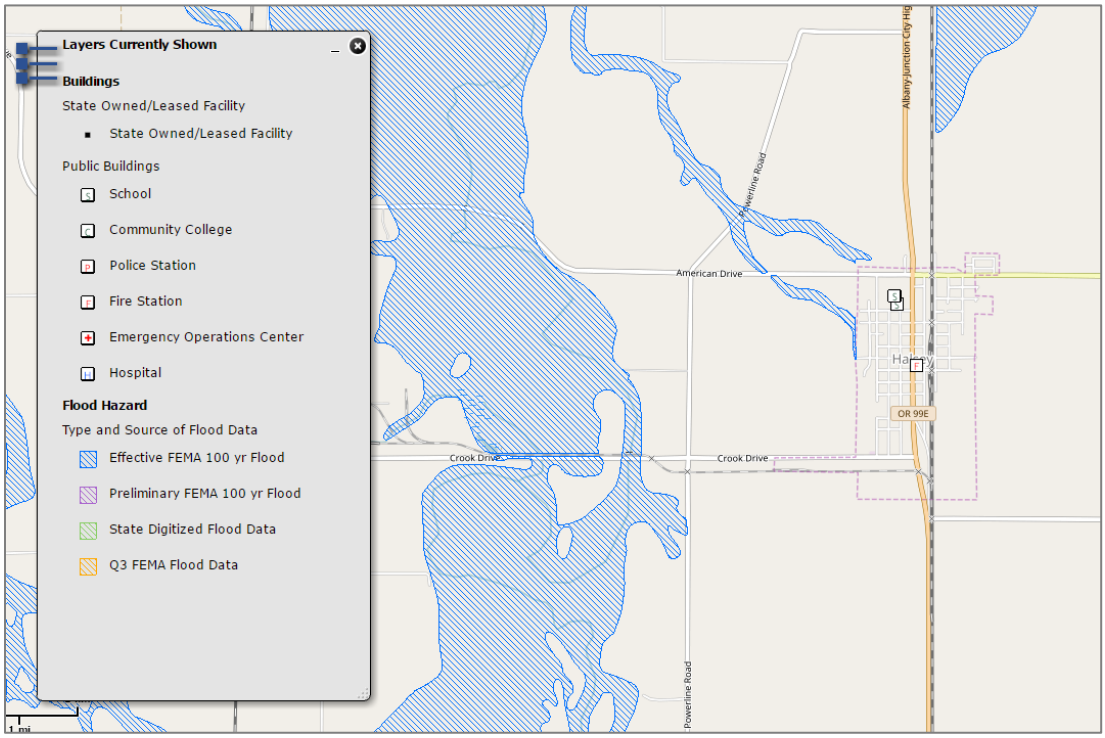
Events: None.

Vulnerability and Impacts: Halsey does not have any special flood hazard areas, as shown in the following figure. However, other portions of Halsey, outside of mapped floodplains, may also be subject to significant, repetitive flooding from local stormwater drainage. Outside of the city limits, flooding occurs in areas along smaller tributary creeks such as Little Muddy Creek to the west and Spoon Creek to the east, along with unnamed minor tributaries and

[8] Regional All Hazard Mitigation Master Plan for Benton, Lane, and Linn Counties: Phase II (2001)

drainage ditches which flow northwesterly through the edge of Halsey, eventually emptying into Muddy Creek several miles north of the city.

Figure HL-2. Special Flood Hazard Area in Halsey



Source: Oregon HazVu: Statewide Geohazards Viewer (DOGAMI)

Smoke/Poor Air Quality

Events: 2020 fires caused smoke in the valley; smoke from the other side of the Coburg hills can move into Halsey.

Vulnerability and Impacts: Older housing stock may present issues of older insulation or none and low likelihood of air filters available in the home.

Wildfire

Events: The September 2020 wildfires were the largest wildfire event in the county. Halsey was indirectly affected by evacuees and by smoke.

Vulnerability and Impacts: Halsey is an occluded area with respect to wildfire because it is somewhat removed from wildland fuels, but still within close proximity to areas with greater probability for burning. The City currently lacks redundancy in the water distribution system due to the failure of one of two wells in 2022. Should the remaining well fail, access to water would be halted. The City of Halsey provides one of the primary water sources for the HSRFD. Loss of the municipal water source would hinder their ability to respond to fires due to unreliable access to a water source.

Winter Storm/Ice Storm

Events: Several winter storms and notable ice storm in February 2021 (DR-4599) and January 2024 (DR-4768).

Vulnerability and Impacts: Halsey has limited infrastructure to plow or de-ice, so the practice is to wait until it melts. The frequency of such events does not justify the cost of equipment. Older homes may be vulnerable, however older homes may also have alternative heat sources such as wood stoves.

Windstorm/Tornado

Events: Several events occurred during the planning period.

Vulnerability and Impacts: Vegetation damage can occur, and some folks may need help clearing tree branches. There are also possible impacts to the transportation network.

Mitigation Strategy

During the 2023-2024 Linn County and Halsey update process, the DLCD planner and the City of Halsey representatives assessed the mitigation strategy actions within the 2017 Jurisdiction Addendum. Together they revised and updated that list of actions to reflect the revised risk assessment for Halsey

Table HL-5. Completed Actions - Halsey

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Pool #9	Drought	Update the Water Management Conservation Plan (WMCP)."	Planning, Public Works	Short-Term	Complete	Update approved by City Council January 2022
Pool #7	Earthquake	Update seismic risk mapping and soil liquefaction mapping around community to direct development away from hazardous areas."	Planning, Public Works, Administration, Fire, Police	Ongoing	Complete	The 2024 DOGAMI report provides mapping of most up to date data on soil liquefaction. Directing development away from these areas is less effective than enforcing current building codes that reduce risk from earthquakes.
Priority #8	Flood	Update applicable City codes to improve risk reduction and prevention of flood impacts.	Planning, Public Works, Administration	Ongoing	Complete	City code about debris and maintenance planning of storm drains. Updated Stormwater Master Plan (draft late 2024) could be a source for future actions.
Pool #10	Flood	Adopt the Oregon Model Companion Flood Damage Prevention Ordinance	Planning, Public Works, Administration	Short-Term	Complete	City updated code to OR model code.
Pool #5	Multi-Hazard	Run DOGAMI HAZUS with local refined data.	Planning, Fire, Police, Public Works, Emergency Management	Short-Term	Complete	The 2024 DOGAMI report includes local refined data.

Table HL-6. Actions Removed from the Halsey Addendum

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Priority #7	Flood	Complete an inventory of locations in city of Halsey subject to frequent storm water flooding outside of designated floodplains.	Planning, Public Works	Long-Term	Remove	Does not apply to Halsey, because the city does not have a mapped SFHA.
Priority #11	Wildfire	Support school education projects related to wildfire.	Fire, Police, Emergency Management, School District	Ongoing	Remove as a stand-alone action	Combined with MH 2 awareness campaign with focus on wildfire.

Table HL-7. Ongoing, Short- and Long-Term Projects – Halsey

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years
**Code: ES = Emergency Services; P = Prevention; PE = Public Education; PL = Planning

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Action Type**	Potential Funding Sources	Notes
Multi-Hazard 1	Provide Emergency Operations Plan awareness training to City staff to ensure understanding of emergency procedures	Administration, Emergency Management, Fire, Police	Ongoing	Revise and retain	PE	City	Revised to focus on EOP. Train staff on implementing emergency operation plans; retrain annually.
Multi-Hazard 2	Develop and promote an educational awareness program about preparedness for natural hazards especially wildfire aimed at the elderly, vulnerable people, and school-aged children.	Fire, Police, Emergency Management, School District	Ongoing	Revise and retain	PE	City, Fire District	Combined with 2017 Priority #11. FD is doing this on an ongoing basis; they used a model of a house with defensible space to show the effect of defensible space on fire movement.

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Action Type**	Potential Funding Sources	Notes
Multi-Hazard 3	Develop an information packet or one-pager for residents to help them prepare to shelter in place and manage without power, utilities, or transportation during a disaster event.	Emergency Management, Fire, Police	Short term	Revise and retain	PE	City; Fire District	Revised to include a specific action of developing information for public awareness and education
Multi-Hazard 4	Communicate with residents and promote readiness. Build cooperative relationships with private businesses for assistance during disaster.	Emergency Management, Fire, Police	Ongoing	Revise and Retain		City, Private	Revised 2017 Pool #6 to include two discrete actions.
Multi-Hazard 5	Create and maintain inventories of at-risk buildings and infrastructure and prioritize mitigation projects	Public Works	Medium term; 3-5 yrs	Retain	P	City	Inventory is a useful thing, will consider how to treat it
Multi-Hazard 6	Coordinate with Fire District to identify and evaluate city-owned emergency transportation routes and determine which roads are critical to the transportation network.	Public Works, Emergency Management, ODOT, Fire	Medium term; 3-5 yrs	Retain and revise	P	City, Fire	In coordination with the Halsey-Shed RFPD to sync up with their evacuation planning efforts.
Multi-Hazard 7	Update Halsey Comprehensive Plan to reflect updated information regarding natural hazards.	Planning, Administration	Long Term	Retain	PL	DLDC, City	Comp Plan not updated since 1990.

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Action Type**	Potential Funding Sources	Notes
Multi-Hazard 8	Create or update a Continuity of Operations Plan (COOP).	Planning, Emergency Management, Fire, Police	Short term; 1-3 yrs	Retain	PL	City	
Multi-Hazard 9	Update emergency operations plan.	Emergency Management, Fire, Police, Planning	Short-term	Retain	PL	City	Estimated completion 2025
Multi-Hazard 10	Install fuel supplies to support generators for wastewater and fresh water source at city hall.	Administration, Public Works	Medium term; 3-5 yrs	New	P	City, FEMA	
Multi Hazard 11	Install a reader board sign at city hall for emergency response and prevention messaging.	City, Fire District, Linn County Sheriff	Medium Term	New		FEMA, OEM,	
Multi Hazard 12	House emergency response supplies including generators, water, food, and Starlink to be deployed in hazard events.	Fire District, City of Halsey	Short term	New		Oregon Chinese Coalition, OEM	
Drought 1	Continue to support measures to reduce water use during drought emergencies by developing a one-pager for residents.	Public Works, Administration, Planning	Short Term	Revise and retain	PE	City	Revised to include specific action to develop outreach materials/one-pager.
Earthquake 1	Provide examples and educational material to support implementation of	Planning, Fire, Public Works	Short-term	Retain	PE	City	

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Action Type**	Potential Funding Sources	Notes
	non-structural mitigation programs in local businesses						
Extreme Heat 1, Smoke / Poor Air Quality 1	Evaluate whether city hall is able to serve as a refuge for residents, including during extreme heat and/or smoke/poor air quality events.	Administration, Public Works	Medium term; 3-5 yrs	New	P	City	
Flood 1	Identify, prioritize, and develop strategies for properties that experience stormwater flooding impacts.	Planning, Administration	Medium Term	Revise and retain		City, BIZ Oregon Planning grant	Revise to be focused on storm water impacts. Implemented a storm-drain maintenance plan to clean out lines.
Wildfire 1	Form a partnership with the Halsey-Shedd Rural Fire District for home site assessments and to support creation of defensible space. Work to provide information about wildfire mitigation to the industrial businesses both on the edges and in the center of Halsey.	Administration, Fire, Police, Emergency Management	Ongoing	Revise and retain	P/PE	OSFM, Fire	Revised to focus on defensible space as a more relevant mitigation strategy. Information and awareness important for the industrial businesses both on the edges and in the center.
Windstorm 1, Winter Storm 1	Provide assistance as needed for debris removal following wind and winter storms.	Fire, Public Works, Emergency Management	Ongoing	Revise and retain	ES	City, FEMA	Developed a pre-strategy for coordinated debris removal. Revised to ongoing. PW helps with tree removal following storms; homeowner responsibility balanced with the need to removal of debris in the ROW.

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Action Type**	Potential Funding Sources	Notes
Windstorm 2 / Winter Storm 2	Develop and implement programs to keep City-owned trees from threatening lives, property, and public infrastructure during wind and winter storms.	Fire, Planning, Parks and Recreation, Administration, Public Works	Short term; 1-3 yrs	Revise and retain	P	City, Grants, FEMA	Revised to relate to the city's tree maintenance program, may develop an urban forestry plan. Purchase a high lift.

Plan Implementation and Maintenance

The City Council will be responsible for adopting the Linn County MJ-NHMP including the City of Halsey Addendum to the Linn County Plan. The Halsey City Administrator is responsible for coordinating implementation and maintenance of the Halsey Addendum to the Linn County MJ-NHMP and will participate in implementation and maintenance meetings. The Halsey representative will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of Halsey's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. The City is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, Halsey will also review and update its addendum. The Halsey City Administrator will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Halsey's Convener determine what components of the mitigation plan need updating.

CITY OF HARRISBURG ADDENDUM

Purpose

This document serves as the City of Harrisburg's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by Harrisburg to improve the resilience of the community. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the Information contained in Volume I (Basic Plan) of this NHMP which serves as the plan foundation and Volume III which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

Harrisburg participated in the Linn County MJ-NHMP for the first time during the 2017 update of the natural hazard mitigation planning process. This is the city's first NHMP update.

During 2023 and 2024 Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities, including Harrisburg, to update their addenda to the Linn County Natural Hazard Mitigation Plan, which expired May 23, 2023.

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the City of Harrisburg will gain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Harrisburg joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on 3/11/2024. On 11/21/2023, 2/7/2024, 3/13/2024, 4/3/2024, and 10/23/24, Harrisburg City Administrator, Michele Eldridge participated in meetings facilitated by DLCD Planner Katherine Daniel to conduct a risk assessment exercise with other county jurisdictions that included a Hazard Vulnerability Assessment ranking. City staff met again with DLCD on 8/8/2024, and on 09/06/2024 to update this addendum.

Harrisburg staff promoted the NHMP survey and outreach efforts throughout the plan update, on the city website, and also at the National Night Out Event held on August 6, 2024.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Harrisburg Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Harrisburg Addendum, are the result of a collaborative effort between residents, public agencies, non-profit organizations, the private sector, and regional organizations. Public officials, including Harrisburg's City Administrator and Public Works Director, guided the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary sections, and Planning and Public Process (Appendix A).

The Harrisburg City Administrator is the designated convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The Harrisburg City Administrator and the DLCD Project Manager revised the Harrisburg Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the update process city staff and other participants provided additional information on potential funding sources, action item prioritization, and local resource and capacity restraints.

The City of Harrisburg advisory group was comprised of the following individuals:

- Michele Eldridge, City Administrator
- Chuck Scholz, Public Works Director

Harrisburg staff used multiple approaches to engage the public. Staff spoke briefly about the plan update at Council meetings during the early meeting dates, and included information on the City website and during the National Night Out event held on August 6, 2024. The advisory group was involved in the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the steering committee were provided an opportunity for comment via the plan review process (see Appendix A for more information).

The Convener for Harrisburg will also remain active in the county's implementation and plan maintenance process; see Volume I, Section 4 for more information.

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[9] This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards*.

Community Profile

This section provides information on city specific assets and populations. For additional information on the characteristics of Harrisburg, in terms of geography, environment,

[9] 44 CFR 201.6(2)(i)

population, demographics, employment and economics, housing, and transportation, see Volume III, Appendix B, Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

Harrisburg was originally incorporated as a city in 1866.[10] The city is located in Linn County, about twenty miles north of Eugene. It occupies an area of about 1.45 square miles (928 acres). The average annual temperature varies from 38°F in January to 84°F in August. The average annual rainfall is about 44.5 inches. Average monthly precipitation varies from about 8 inches in December to about 0.5 inches in July.

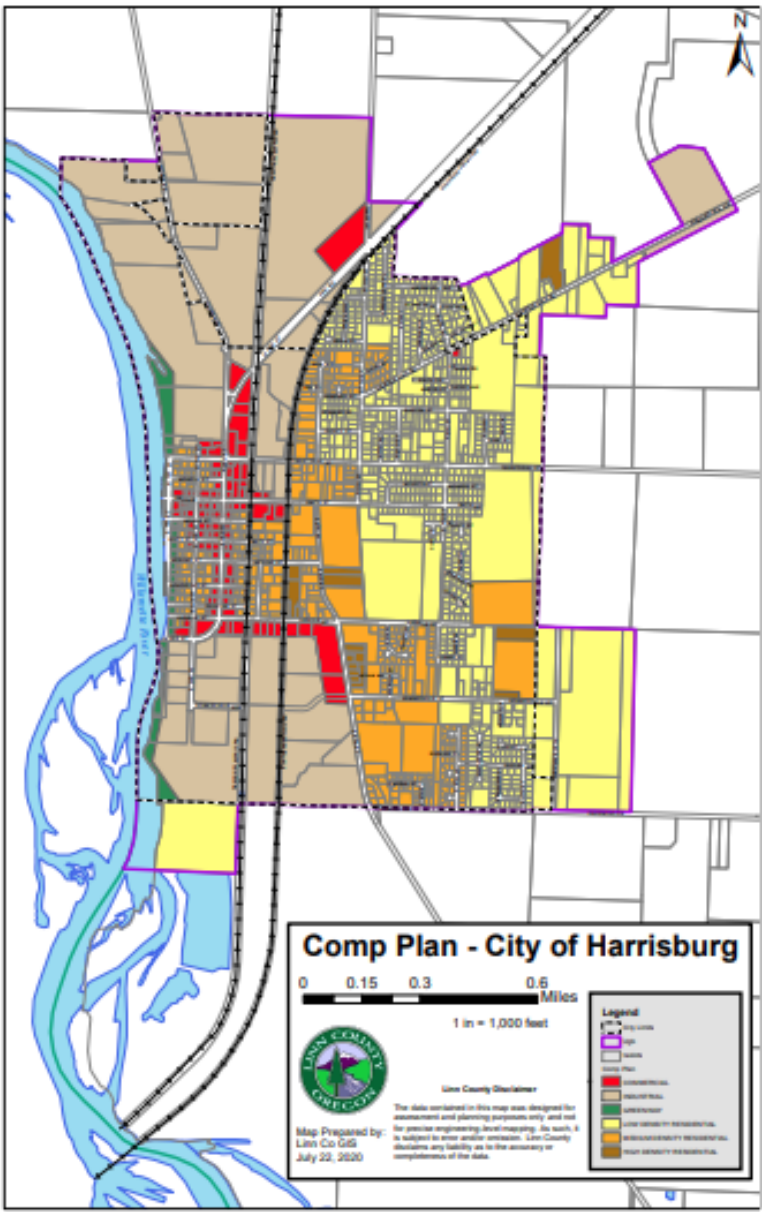
Due to its location in the Willamette Valley, Harrisburg's topography is relatively flat. However, the Cascade Mountains begin approximately 30 miles to the east. Nearby rivers include the Willamette, which runs along the western boundary of the city limits, and the Muddy River to the east.

The Population Research Center at Portland State University lists Harrisburg's 2023 population at 3,660. This represents a minimal increase from 2015 (3,645). For more demographic information, refer to Appendix B.

Historically, Harrisburg was an agricultural and railroad community. Although agriculture is still an important industry in the surrounding areas, about two-thirds of the labor force in Harrisburg are now employed in services, retail trade, and manufacturing.[11] Like many small communities in Oregon, a large portion of Harrisburg's residents commute outside of the city limits for work, primarily to larger nearby urban centers such as Eugene/Springfield and Corvallis/Albany. Median household income in Harrisburg in 2022 was $51,708. For more economic information, refer to Appendix B.

[10] http://www.tri-countychamber.com/communities/local-history/
[11] Business Oregon – Oregon Prospector. Total Employees by Major SIC (2017) for Harrisburg, OR. http://oregon.zoomprospector.com/

Figure HB-1. Harrisburg Comprehensive Plan Map



Source: Harrisburg Comprehensive Plan, 2020

Critical and Important Facilities

Harrisburg's critical and important facilities include the following:

- City Hall, 120 Smith St, Harrisburg, OR 97446
- Harrisburg Fire and Rescue Station 41, 440 Smith St, Harrisburg, OR 97446
- Harrisburg High School, 400 S 9th St. Harrisburg, OR 97446
- Harrisburg Elementary and Middle School, 642 Smith St. and 201 6th St, Harrisburg, OR 97446
- Linn County Sheriff's Office, Harrisburg Substation, 120 Smith St, Harrisburg, OR 97446

Additional important facilities in Harrisburg include a local church building that includes kitchen facilities and 19,000 square feet of floor space that could accommodate a large group of people. A gym was added to the facility in the early 2000's. Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information. Two lifeline facilities, the church and a business with fuel supply, were included in DOGAMI's analysis and were not found to be vulnerable.

Transportation

The major transportation networks for Harrisburg are Highway 99E, which leads to the I-5 corridor, and Peoria Road/Coburg Road. Each of these has the potential to be impacted by local flooding events. Diamond Hill Road connects to Interstate-5 and is a truck route, while Territorial Street connects with Powerline Road, a minor arterial between Coburg and Harrisburg.

Highway 99E crosses the Willamette River on a bridge which is maintained by the Oregon Department of Transportation (ODOT). The bridge is over 100 years old and is a critical connection to Lane County. The concern over the seismic stability of this bridge has led the City to join with Coburg for co-servicing on traffic enforcement because these two cities are located on the same side of the river.

Road	Owner	Notes
OR-99E	ODOT	North/South route within the city
N. Coburg Rd./6th St.	Lane & Linn Counties	North/South route within the city
Railroad lines	Union Pacific & Burlington Northern	
Peoria Rd.	Linn County	North/South route within the city
Diamond Hill Dr.	City of Harrisburg/Linn County	East/West route within the city
Territorial St..	City of Harrisburg/Linn County	East/West route within the city

Energy

The City has a franchise agreement with Pacific Power, and there is a substation located in Harrisburg on Diamond Hill Road, adjacent to the BNSF train tracks. Harrisburg has an alternative to electric service through a franchise agreement with Northwest Natural Gas. Many homes have gas services; the City also has a large generator service that is wired into City Hall. This makes for a seamless transition when power fails. There are generators wired into the main infrastructure for water/wastewater, ensuring that for most critical infrastructure services the City has what is needed to safely serve the citizens of the community. This robust response system includes several mobile generators that can be taken to various lift stations and pump stations throughout town. These stations are not large enough to warrant their own generators but are needed for the operation of the entire system. This allows the system to continue to operate during power outages.

Harrisburg Fire Rescue District also has two generators that can power the entire station; one is wired into the system to start operation upon any power outage. They also built the station to accommodate loss of power, with their own gas and diesel tanks on the property. These are also wired into the generator, ensuring that pumps can operate during a prolonged power outage, and allowing crucial emergency vehicles that can still respond to emergency calls.

Water/Wastewater

The Harrisburg water system currently consists of five wells, two storage tanks (one holding 2 million gallons in a concrete reservoir that was deemed structurally deficient and another holding 0.6 million gallons in a steel tank), a pump station, and 17.2 miles of water lines. Four of the five wells are located south of the City Shops on the southwest side of the city. The water from these wells is combined in two reservoirs before entering the distribution system. One well is located on the north side of Harrisburg on the same property as the wastewater treatment facility and is fed directly into the north end of the distribution system through its own entry point. Through a long and complex process, including the successful drive to obtain General Obligation Bonds, the City has worked steadily with several specialized consulting firms to update the Water Master Plan and determine the best way to improve the aesthetic quality of the water. The water is safe to drink, but there are high levels of iron, manganese, hydrogen sulfide, dissolved solids, and chlorides that impact the aesthetic features of the water.

The Water Bond project includes two new water filtration systems and two new storage tanks, replacement of one well, and replacement of 3.5 miles of main water lines. It also includes installation of telemetry to allow both the north and south water plants to connect with each other. The construction of these filtration plants and reservoirs will likely be complete in late 2026. The City retains water rights to the Willamette River, and will determine next steps in 2027.[12]

Harrisburg's wastewater treatment facility is located on the east bank of the Willamette River on the north-western side of town. This system operates with a single pump which transfers wastewater to the central treatment plant. The wastewater is currently treated in two 9-acre primary facultative lagoons, two 4-acre secondary facultative lagoons, and two 1-acre submerged rock polishing ponds. The facility is located 1.5 miles north of the town on Peoria Road. The facility was constructed in 1991 and upgraded to double its original size to its current capacity in 2004. The raw sewage enters the facility and flows through the primary lagoon, secondary lagoon, polishing ponds, and a chlorine contact chamber. Effluent from the facility is discharged to the Willamette River from November through April and is spray irrigated on the adjacent poplar trees from May through October.[13]

The City's existing gravity sewer system contains approximately more than 59,000 feet of sewers ranging from 4-inch to 16-inch in diameter. The older sewers consist of concrete pipe and asbestos cement pipe. Newer sewers installed are polyvinyl chloride (PVC). PVC pipe is manufactured in longer lengths than concrete pipe so has fewer joints which are more watertight.[14]

Emergency Services

The Harrisburg Fire and Rescue District (HFRD) is a separate taxing district from the City. The Fire Station is a critical structure that can continue operating during power outages and inclement weather. They have advanced EMT services and respond to medical

[12] Water System Upgrades - Construction continues at both the North and South Water Plant!
[13] Sewer System | City of Harrisburg Oregon
[14] Ibid.

emergencies, as well as car crashes, fires, and other types of emergencies. Ambulances are available through centralized hospital services located in Albany, Corvallis, and Eugene.

Community Assets, Vulnerable Populations, and Plans and Policies

Cultural Events/Historical Resources

The City hosts numerous festivals throughout the year, including the Harvest Festival Tractor & Truck Pull, a regional 4th of July Celebration in its 73rd year of operation, a Holiday Light Parade, and the Multi-Cultural Festival. There are also weekly summer concerts at the gazebo during July and early August.

Functional and Access Needs of Vulnerable Populations

Harrisburg has a population with a median age below the county average and with a higher ratio of children to working aged people, also called the Child Dependency Ratio. Harrisburg households include 8.3% of households that are headed by single parents with children under the age of 18. Median household income in Harrisburg is below the county average. Poverty for children in Harrisburg has been reduced from 36% in 2015 to 14.3% in 2022, while poverty among those 65 or older almost tripled during the same time period. Regarding the built environment, 23% of the housing units in Harrisburg are mobile homes, higher than Linn County at 14.8%. For more demographic and housing information, refer to Appendix B: Community Profile.

Plans and Policies

The Harrisburg Comprehensive Plan was acknowledged by the Oregon Land Conservation and Development Commission in 1982. The City last amended the plan in 2013. The city implements the plan through the City of Harrisburg Zoning and Development Code, which was last revised February 1, 2024.

Harrisburg currently has the following plans that relate to natural hazard mitigation, available for online review or by request:

- Comprehensive Plan (amended 2013)
- Zoning and Development Code (amended 2/1/2024), including Section 18.55.070 Flood hazard management statutory authority, findings of fact, purpose and methods
- Transportation System Plan (1999), currently being updated, adoption pending in Fall 2025.
- Water Conservation Master Plan (June, 2010)
- Water Master Plan (2019)
- Parks Master Plan (2022, integrates with flood/wetland/riparian management)

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's mitigation strategies. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city has identified mitigations actions that will help to increase Harrisburg's overall mitigation capability.

Hazard Profile

The DOGAMI Multi-Hazard Risk Assessment (MHRA) report analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the follow tables. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table HB-1. City of Harrisburg Hazard Profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Harrisburg		3,660	1,924		5	544,762,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	162	4.4%	403	0	65,086,627	12%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	1	0%	5	0	2,878,941	0.5%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	228	6.2%	76	0	22,789,000	4.2%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Source: DOGAMI Multi-Hazard Risk Report, 2024

Table HB-2. City of Harrisburg Critical Facilities

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Harrisburg City Hall	-	-	-	-	-
Harrisburg Fire and Rescue - Station 41	-	-	-	-	-
Harrisburg High School*	-	-	-	-	-
Harrisburg Middle School/Elementary School*	-	-	-	-	-
Linn County Sheriff's Office – Harrisburg Substation	-	-	-	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.

Source: DOGAMI Multi-Hazard Risk Report, 2024

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the jurisdiction representatives first updated the description, type, location, and extent of each hazard. Next, they updated the Hazard Analysis Methodology based on each hazard's potential impact on the county as a whole. The results of that exercise are provided in Table HB-3.

In this analysis, severity ratings, and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2, Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

This method provides the City of Harrisburg with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The City of Harrisburg representatives refined the risk assessment with guidance provided by the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table HB-4, below, represents the variation in total risk to the natural hazards as experienced in the City of Harrisburg representatives compared to the county level ranking completed by the Steering Committee.

Winter Storm was revised in 2024 to include Ice Storms and remains the top-ranking hazard for the county and the city. Extreme Heat and Smoke/Poor Air Quality, both newly identified hazards in this update, were ranked highly by both City representatives and by the Steering Committee. Flood and Cascadia Earthquake were ranked among the hazards of highest concern for the City. Windstorms also ranked more highly by the city, from the lower tier to the middle tier of hazards, than by the Steering Committee.

The Harrisburg staff identified the risk of volcanic ash impacting the wastewater treatment lagoons as happened during the Mt. St. Helens eruption.

The City does not consider Dam Failure or Landslide to be hazards that require mitigation action by the city and therefore, they do not intend to identify mitigation actions for those hazards.

Table HB-3. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table HB-4. Relative Risk of Natural Hazards in Harrisburg

	Total Score	
HAZARD	**County**	**Harrisburg**
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	↑
Drought	169.0	same
Earthquake (Cascadia)	160.7	↑
Wildfire	158.9	same
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	n/a
Windstorm/Tornado	116.5	↑
Volcano	109.0	same
Landslide and Avalanche	106.4	n/a

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Harrisburg. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Harrisburg Hazard Profile and Critical Facilities tables (HB-1 and HB-2) included above, this section identifies vulnerabilities specific to Harrisburg, recent localized hazard events and impacts, and illustrates the basis for the city's HVA scores.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018, and 2021-2023.

Vulnerability and Impacts: Those who rely on regular precipitation for dry land farmed agricultural crops may be the most vulnerable to drought conditions. Firefighting capacity can also be reduced due to higher water consumption in the City.

Earthquake

Events: None.

Vulnerability and Impacts: Older building stock is a concern. The ODOT-maintained Highway 99E bridge which crosses the Willamette River is of concern related to seismic stability. Seismic upgrades have been made at Harrisburg Elementary/Middle School and Harrisburg High School.

Extreme Heat

Events: Excessive heat and high heat events in 2017, 2021, and 2022.

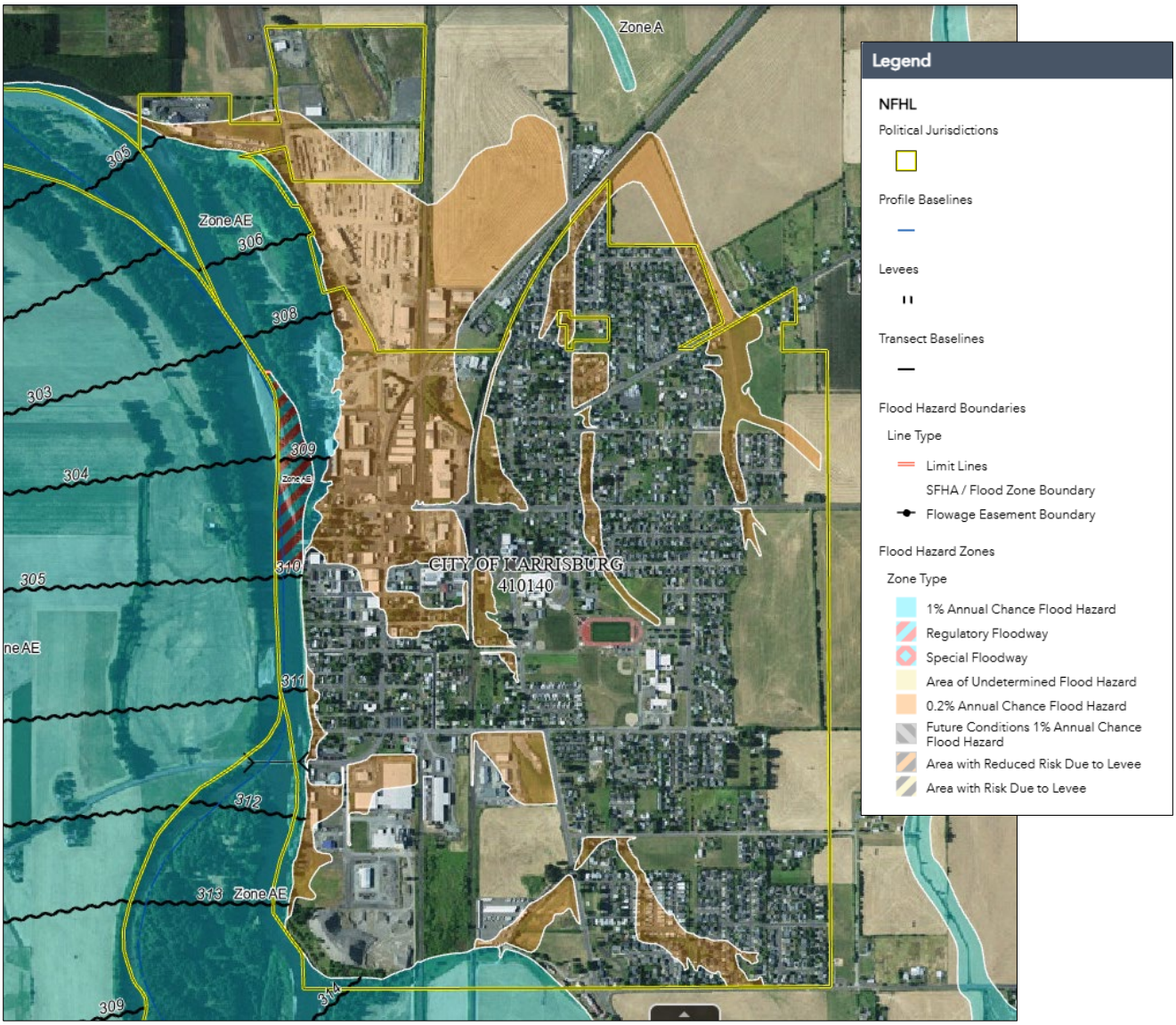
Vulnerability and Impacts: Older homes may lack sufficient insultation or lack air conditioning available. During the 2021 heat dome, the Harrisburg Library extended hours to provide a cooling space for residents without sufficient cool space at home. Policy requires that temperatures exceeding 95 degrees warrant additional hours for the Library and that it open as a cooling center.

Flood

Events: In April 2019 the Willamette River near Harrisburg crested at 15.3 feet around 9 AM on April 9 (1.3 feet above flood stage).

Vulnerability and Impacts: Homeowners throughout town were impacted by an extremely high water table; drainage throughout infrastructure was very slow. Harrisburg's mapped flood hazard zones are shown in the following figure.

Figure HB-2. Special Flood Hazard Area in Harrisburg



Source: FEMA's National Flood Hazard Layer (NFHL) Viewer

Smoke/Poor Air Quality

Events: September 2020 wildfires caused smoke in the Willamette Valley.

Vulnerability and Impacts: Residents with respiratory problems were impacted, with increased emergency calls for HFRD.

Volcano

Events: No events since 2017.

Vulnerability and Impacts: Risk of volcanic ash impacting the wastewater treatment lagoons.

Wildfire

Events: The September 2020 wildfires were the largest wildfire event in the county.

Vulnerability and Impacts: Harrisburg was affected indirectly by smoke and visibility issues. HFRD and other fire/rescue districts were impacted by responding to wildfires in both Linn and Lane County, resulting in less coverage for local emergencies.

Winter Storm/Ice Storm

Events: Several winter storms and a notable ice storm in February 2021 (DR-4599) and January 2024 (DR-4768).

Vulnerability and Impacts: Poplar trees in the wastewater facility were affected; these trees are part of the wastewater treatment system. Electricity was lost and the lift stations were not able to pump stormwater. Extended extreme weather conditions stress the capacities of the City's infrastructure, which could lead to unsanitary conditions for the community and the environment.

Windstorm/Tornado

Events: Strong wind events occur nearly annually in the Southern Willamette Valley.

On June 18, 2023, a brief, weak tornado (EF0) touched down about 5 miles east of Harrisburg and moved east-northeast across I-5 before dissipating. No damage was reported from this tornado.

Vulnerability and Impacts: Loss of electricity, tree limbs down in streets and parks.

Mitigation Strategy

During the 2023-2024 Linn County and Harrisburg update process, the DLCD planner and Harrisburg representatives assessed the mitigation strategy actions within the 2017 Harrisburg Addendum. Together they revised and updated that list of actions to reflect the revised risk assessment for Harrisburg.

Table HB-5. Completed Actions - Harrisburg

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Priority #4	Multi-Hazard	Develop public education efforts about the natural hazards Harrisburg is vulnerable to and mitigation measures residents can implement.	Administration, Emergency Management	Ongoing	Complete	The city has developed methods to conduct outreach. The city maintains a section on the website with hazard planning resources and information. https://www.ci.harrisburg.or.us/community/page/harrisburg-emergency-system-alert The city also sends monthly newsletters to keep residents aware of relevant information for current natural hazard concerns such as how to mitigate the effects of extreme heat and poor air quality including resources for access to services provided by non-profit, county, state and federal agencies.
Priority #11	Earthquake	Inventory critical infrastructure or facilities vulnerable to seismic risk and consider options for seismic retrofit.	Planning, Public Works, Emergency Management	Short term	Complete	DOGAMI report provided this with update.

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Pool #3	Multi-Hazard	Integrate the risk assessment and action items from the Harrisburg Natural Hazards Mitigation Plan into existing regulatory documents and programs, such as the comprehensive plan or zoning ordinance, where appropriate.	Planning, Parks and Recreation	Ongoing	Complete	The Comprehensive Plan and Zoning & Development Code Update integrated risk assessment and action items from the NHMP. Another example of integration of planning documents is the development of TSP to include improvements to evacuation routes.
Pool #5	Earthquake	Update seismic risk mapping and soil liquefaction mapping around community to direct development away from hazardous areas.	Planning, Public Works	Long term	Complete	The 2024 DOGAMI report provides mapping of most up to date data on soil liquefaction. Directing development away from these areas is less effective than enforcing current building codes that reduce risk from earthquakes.
Pool #6	Flood	Encourage development of acquisition and management strategies to preserve open space for flood mitigation, fish habitat, and water quality in the floodplain and reduce risk to flood prone properties as well as preserve space for open space property.	Planning, Public Works, Parks and Recreation, Administration	Ongoing	Complete	The city purchased a former gravel mine site in 2020 that is in the last phase of reclamation. The land is designated as undeveloped park land called Eagle Park. It is comprised of 132 acres located along the Willamette River and includes three large ponds and an expanse of greenway along the river.
Pool #7	Severe Weather (Winter Storm/ Windstorm)	Develop and implement landscaping and tree standards to keep trees from threatening lives, property, and public infrastructure	Planning, Public Works	Short term	Complete	The development code and tree code were revised to address planting and maintenance of street trees, and it includes a tree list to identify deep rooted trees with characteristics suitable to location in the public right of way.

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Priority #1	Multi-Hazard	Update emergency operations plan.	Planning, Administration, Public Works	Ongoing	Complete	The city continues to update the ERP as needed. This was done most recently in January 2024. The city actively implements and updates this plan with exercises and non-natural hazard responses.

Table HB-6. Actions Removed from the Harrisburg Addendum

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Priority #8	Flood	Research potential stormwater management strategies such as developing bioswales, to reduce flooding in areas within and outside the designated flood plain.	Planning, Public Works	Ongoing	Remove	The high water table in Harrisburg precludes much use of bioswales for stormwater management.
Priority #12	Drought	Coordinate actions between the Water Management and Conservation Plan (WMCP) and the city Comprehensive Plan.	Public Works, Administration, Planning	Ongoing	Remove	The WMCP is not intended to be incorporated into the Comprehensive Plan.
#1	Multi-Hazard	Assist K-12 schools, childcare facilities and schools to develop vulnerability assessments and mitigation projects to improve safety.	Planning, Fire, Police, School District	Ongoing	Remove	The city does not have the capacity to implement this action. This action is the purview of the school district.

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
#4	Drought	Support local agency programs that promote measures to reduce water use during drought emergencies.	Planning, Administration	Ongoing	Remove	This is a repeated action.

Table HB-7. Ongoing, Short-, and Long-Term Projects – Harrisburg

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 1	Provide information to residents and business owners about how to manage without power, utilities, or transportation during disaster event; how to communicate should the power go out and how to promote readiness. Build cooperative relationships with private businesses for assistance during disaster.	Emergency Management, Fire, Law Enforcement, Planning	Ongoing	Retain; revised	City budget, Grants, including those geared towards businesses	City continues to provide information on preparedness and resources for residents on natural hazard mitigation through the city website and through monthly newsletters. Revised to identify this as a public education action.
Multi-Hazard 2	Provide awareness training to city staff regarding the key elements of the ERP and the COOP when it is completely revised.	Planning, Emergency Management, Fire, Law Enforcement	Ongoing	Retain; revised	City budget	Training is provided annually or biannually for the elements of the ERP and a process for revisions and updates is in place. As the COOP is reconstructed the city will develop awareness training for city staff to support

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
						resilience following a natural hazard event.
Multi-Hazard 3	Complete development of, begin to maintain and educate city staff about the Continuity of Operations Plan (COOP).	Planning, Administration	Long term	Retain; revised	City budget	Although the COOP was lost due to the company going out of business without providing a workable document to the city, the city places a high priority on reconstructing the COOP. This work is partially done and will include an educational component with the other groups identified.
Drought 1	Continue to implement programs and planning that promote measures to reduce water use, reducing risk from drought through conservation, via implementation of the City's Water Conservation Management Plan.	Emergency Management, Planning, Administration	Ongoing	Retain; revised	City budget	
Earthquake 1	Encourage earthquake proofing with residents, business, and other groups through public education.	Fire, Law Enforcement, Emergency Management, Planning	Ongoing	Retain; revised	City budget, Linn Co EM	Earthquake risk reduction is supported by the construction of a new fire station. The school district proposed and passed a bond for seismic retrofits to the schools. Action revised to focus on public education about earthquake risk reduction methods.

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Flood 1	Ensure continued compliance in the National Flood Insurance Program (NFIP) through encouragement of improved floodproofing and application of the provisions of flood damage prevention in the Harrisburg Development Code.	Planning, Public Works, Administration	Ongoing	Retain; revised	City budget	There is no more vacant land located in the floodplain in Harrisburg, so little new construction is anticipated there. The city is working with property owners whose ownership or tenancy predates the NFIP to encourage best practices in floodplain management.
Flood 2	Complete an inventory of locations in city of Harrisburg subject to frequent storm water flooding outside of designated floodplains	Public Works, Planning	Short term	Retain - Progressing	Storm Drainage fees	A Storm Drainage fee was established to support an inventory and analysis of stormwater overflows. The area of N. 7th Pl, and Burton St. continues to be an area of particular concern.
Flood 3	For locations with repetitive flooding and significant damages or road closures, determine and implement mitigation measures such as upsizing culverts or storm water drainage ditches.	Public Works, Planning	Long term	Retain - Progressing	City Capital Improvement Plan	
Flood / Channel Migration 4	Conduct a Channel Migration Risk Study on the Willamette River in Linn County. Study feasibility of options for bank stabilization on the Willamette River	Harrisburg & Linn Co. Emergency Management, DOGAMI	2-5 years	New	FEMA HMGP, FEMA FMA, FEMA CTP	DOGAMI has completed a Channel Migration Zone (CMZ) study for the Santiam River, but the extent of the Willamette River is unmapped for CMZ. Additional studies are needed to outline feasible solutions for

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
						bank stabilization in particular areas.
Flood / Channel Migration 5	Stabilize rapidly eroding/migrating riverbanks to reduce risk to communities along the Willamette River in Linn County	Harrisburg & Linn Co. Emergency Management	2-5 years	New	FEMA HMGP, FEMA FMA, OWEB Grants	Particular bank erosion risk observed along the Willamette River near Harrisburg. See Umatilla Co. McKay Creek Basin Stabilization Project as an example.
Volcano 1	Evaluate capability of the water treatment plant to deal with high turbidity from ash falls. Include volcanic hazards in the Harrisburg Emergency Operations Plan and water treatment plant operations plan.	Public Works	Long term	New	City budget and Capital Improvement Plan	

Plan Implementation and Maintenance

The City Council is responsible for adopting the Linn County MJ-NHMP including the City of Harrisburg Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP). The City Administrator is responsible for coordinating implementation and maintenance of the Harrisburg Addendum to the Linn County MJ-NHMP and will participate in the Linn County NHMP implementation and maintenance meetings. The Harrisburg representative will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of Harrisburg's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. Harrisburg is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, Harrisburg will also review and update its addendum. The Harrisburg Convener will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Harrisburg's Convener determine what components of the mitigation plan need updating.

CITY OF LEBANON ADDENDUM

Purpose

This document serves as the City of Lebanon's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by Lebanon to improve the resilience of the community. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the information contained in Volume I (Basic Plan) of this NHMP which serves as the plan foundation and Volume III which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

Lebanon participated in the Linn County MJ-NHMP for the first time during the 2017 natural hazard mitigation planning process. This will be the City's first update.

During 2023 and 2024 Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (OEM), and Linn County cities, including Lebanon, to update their addenda to the Linn County Natural Hazard Mitigation Plan, which expired May 23, 2023.

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the City of Lebanon will gain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Lebanon joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on 2/12/2024. On 2/7/2024, 3/13/2024, 4/3/2024, 7/17/2024, and 10/24/24, Lebanon's Engineering Services Director, Ron Whitlatch, Community Development Director, Kelly Hart, and the Public Works Operations Manager, Jason Rush participated in meetings facilitated by DLCD including to conduct a risk assessment exercise with other county jurisdictions that included a Hazard Vulnerability Assessment ranking. City staff met again with DLCD on 8/16/2024 to update this addendum.

Lebanon staff promoted the NHMP survey and outreach efforts throughout the plan update, by posting on the city's webpage and social media outlets starting on August 22, 2024.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Lebanon Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Lebanon Addendum, are the result of a collaborative effort between citizens, public agencies, non-profit organizations, the private sector, and regional organizations. Public officials guided the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary sections, and Planning and Public Process (Appendix A).

The Lebanon Engineering Services Director is the designated Convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The Lebanon Engineering Services Director, the Planning Director, and the Public Works Operations Manager and the DLCD Project Manager revised the Lebanon Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the update process city staff provided additional information on potential funding sources, action item prioritization, and local resource and capacity restraints.

The City of Lebanon advisory group was comprised of the following individuals:

- Ron Whitlatch, Engineering Services Director
- Kelly Hart, Community Development Director
- Jason Rush, Public Works Operations Manager

Lebanon city staff used multiple approaches to engage the public. These approaches included a public survey posted on the City's webpage and social media outlets, and posting the draft plan on the City's webpage. The advisory group was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the steering committee were provided an opportunity for comment via the plan review process (see Appendix A for more information).

The Convener for Lebanon will also remain active in the county's implementation and plan maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[15] This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards*.

Community Profile

This section provides information on city specific assets and populations. For additional information on the characteristics of Lebanon, in terms of geography, environment, population, demographics, employment and economics, housing, and transportation see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for

[15] 44 CFR 201.6(2)(i)

natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

Lebanon was incorporated as a city in 1878.[16] The city is located in Linn County, about 19 miles east of Corvallis. It occupies an area of about 6.9 square miles (4,397 acres).

Lebanon is located east of the Willamette River in the Willamette Valley zone of the Oregon Climate Service. The climate is generally mild throughout the year and features cool, wet winters and warm, dry summers. Average annual precipitation in Lebanon is approximately 57 inches. Annual primary precipitation occurs in November, December, January, and February. Storms during the winter rainy season are often of long duration, extending two to three days. Shorter duration events are typical in spring and last a few hours. Snowfall is minimal: Most years record little snowfall, and the mean annual snowfall for this area is between 5 inches and 10 inches. The average annual temperature is 52°F, with an average high of 81°F in August and an average low of 33°F in January.

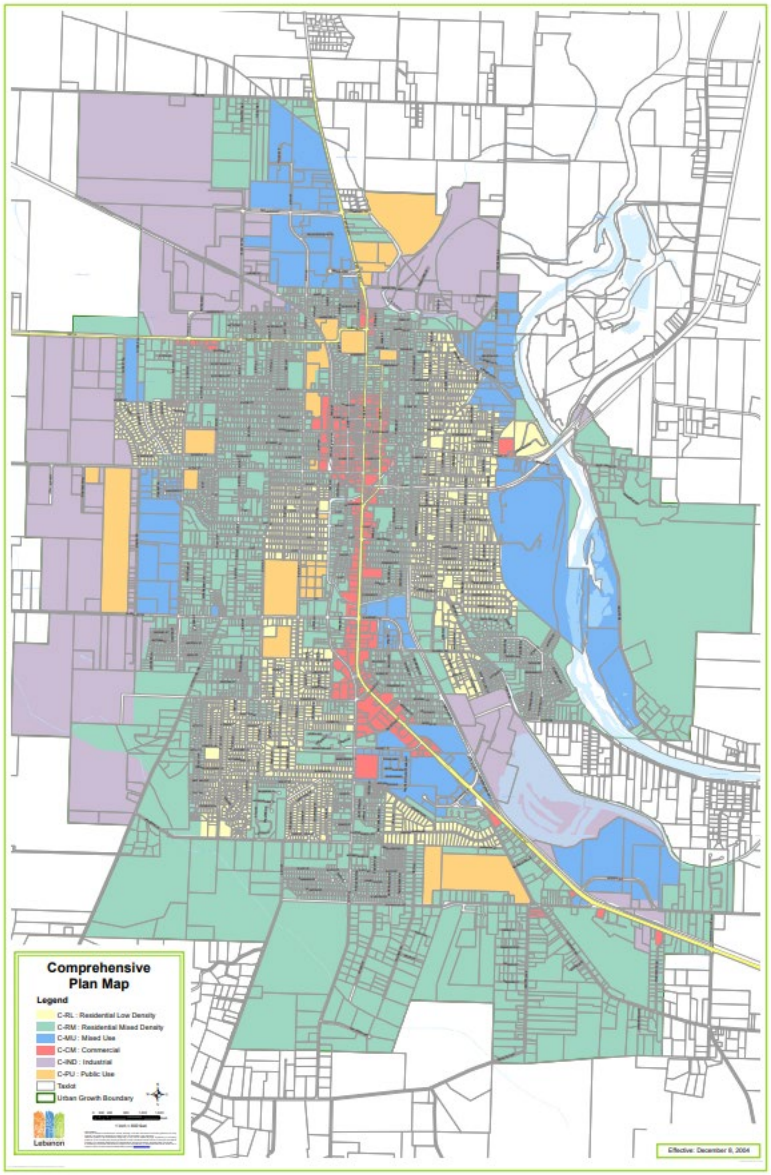
Due to its location in the Willamette Valley, Lebanon's topography is relatively flat. Nearby rivers include the South Santiam which runs along the eastern boundary of the city limits. Lebanon is located at the base of the Cascade Mountain range, at the eastern boundary of the Willamette Valley. The only area in Lebanon with steep slopes is the area east of the Santiam River, which includes the Ridgeway Butte area. It is relatively undeveloped forested land that drains directly into the Santiam River. Generally, the ground slopes downward from the southeastern city limits to the northwestern city limits, with a change in elevation of approximately 55 feet over 23,250 feet (4.4 miles) for an average slope of 0.2 percent.

The Population Research Center at Portland State University lists Lebanon's 2023 population at 20,329. This represents an increase from 2015 when the population was 15,740. For more demographic information, refer to Appendix B: Community Profile.

Historically, Lebanon was an agricultural and timber community. Although agriculture is still an important industry in the surrounding areas, about two-thirds of the labor force in Lebanon are now employed in services, retail trade, and manufacturing.[17] Like many small communities in Oregon, a large portion of Lebanon's residents commute outside of the city limits for work, primarily to larger nearby urban centers such as Corvallis/Albany, Eugene/Springfield, and Salem. Median household income in Lebanon in 2022 was $53,246. For more economic information, refer to Appendix B: Community Profile.

[16] Oregon Blue Book, Incorporated Cities: Lebanon, https://sos.oregon.gov/blue-book/Pages/local/cities/l-r/lebanon.aspx.
[17] Business Oregon – Oregon Prospector. Total Employees by Major SIC (2017) for Lebanon, OR, http://oregon.zoomprospector.com/, accessed August 28, 2017.

Figure LB-1. Lebanon Comprehensive Plan Map



Source: City of Lebanon

Critical and Important Facilities

Lebanon's critical and important facilities include the following:

- Samaritan Lebanon Community Hospital, 525 Santiam Highway SE
- Lebanon Fire District – Station 34, 37919 Weirich Drive
- Lebanon Fire District: Training Division – Station 31, 1050 W Oak Street
- City Hall, 925 Main Street
- Lebanon Justice Center (Police Department), 40 N 2nd Street (EOC)
- Linn County Sheriff, 2590 S Main Road
- City Public Works Facility, 305 W. Oak Street
- Lebanon Public Library, 55 Academy Street

- Lebanon State Airport, 1750 W Airway Road

Lebanon's critical infrastructure includes the following:

- Water Treatment Plant, 2500 River Rd.
- Water Intake, 37928 River Dr.
- Wastewater Treatment Plant, 33110 Tennessee Rd.
- Montessa Drive Pump Station, 900 Montessa Way
- Park Drive Pump Station, 2048 Park Drive
- Weirich Drive Pump Station
- Isabella Street Pump Station
- Grant St. Reservoir, 37919 E Grant St.
- S 5th St Reservoir, 31399 SW 5th Street

Lebanon has the following schools which serve critical needs in the community from within the city limits:

- Cascades School, 2163 South 7th Street (Temporary Shelter)
- Green Acres School, 700 South 10th Street (Temporary Shelter)
- Lebanon Union High School, 1700 South 5th Street (Temporary Shelter)
- Pioneer School, 500 North 5th Street (Temporary Shelter)
- Riverview Elementary School, 1011 Mountain River Drive (Temporary Shelter)
- Seven Oak Middle School, 550 Cascade Drive (Temporary Shelter)
- Linn-Benton CC Advanced Transportation Technology Center, 2000 W Oak Street
- Western University of Health Sciences, 200 Mullins Drive (Temporary Shelter)
- Western University of Health Sciences, 2665 S Santiam Highway

Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E, listed under general names; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information. These include elder care facilities, food distribution facilities, the community center, communications facilities, and financial institutions.

The City also maintains a map with evacuation routes and American Red Cross temporary shelters. To view the map, visit this link[18] on the city's Emergency Management website.

Transportation

The primary transportation networks are Highway 20 to the north and west, and Highway 34 to the west. Interstate 5 is approximately 9 miles to the west and provides the major economic corridor for Lebanon and surrounding region.

Road	Owner	Notes
OR-20	ODOT	North/South route through the city
OR-34	ODOT	Western route from city center
Railroad	AERC	N/S route through the city

[18] https://www.lebanonoregon.gov/DocumentCenter/View/536/Emergency-Map-with-Evacuation-Routes-and-Evacuation-Shelters-PDF?bidId=

Energy

Pacific Power (PacificCorp) provides electric utilities in Lebanon, and NW Natural provides natural gas. Backup generators are available for the Justice Center, the Wastewater Treatment Plant, the Water Treatment Plant, Water Intake, Public Works Facility, and the pump stations.

Water/Wastewater

The City of Lebanon receives water from the South Santiam River through a water intake built in 2018. The surface water is then pumped to the new Lebanon water treatment plant. The plant treats the surface water through a combination of micro-filtration technology and disinfection to provide clean, safe drinking water. The water plant is operated by the City of Lebanon and produces an average of 2 million gallons per day and has an effective capacity of 4.5 million gallons per day.

Transmission, storage, and distribution of the water after treatment is handled by the water section of the Public Works Maintenance Services Division. The city has approximately 80 miles of water main ranging in size from 2 to 16 inches in diameter. Information on the water flow at different fire hydrants in the city is indicated by the color of the hydrants. This helps the Fire District to locate the right hydrant when fighting a fire.

Lebanon's wastewater treatment facility is located approximately 1/3 mile downstream from the Grant Street Bridge. The plant is an 8-million gallon per day, activated sludge system providing secondary treatment and chlorination before discharge into the South Santiam River. The treated biosolids from the process are deposited as fertilizer on local agricultural land. The operations of this facility are managed by the City of Lebanon.

Emergency Services

The City maintains police services. Fire and paramedic services are provided by the Lebanon Fire District.

Community Assets, Vulnerable Populations, and Plans and Policies

Cultural/Historical Resources

The City of Lebanon recognizes that certain significant historic resources are located within its boundaries and contribute to the unique character of the community. The city maintains an extensive list of historical properties[19] identified as irreplaceable and that merit preservation.

Unreinforced masonry buildings are very vulnerable to damage by earthquakes.

Functional and Access Needs of Vulnerable Populations

Median age in Lebanon is lower than the county average, but the Child Dependency Ratio is approximately the same as the county's indicating there may be some younger families without children in Lebanon as compared to the average for the county. Other demographic

[19] https://www.lebanonoregon.gov/224/Historical-Properties

data indicate that 4.9% of the population speaks English less than "very well" and the median income is below the county average.

Within the built environment nearly 25% of the housing stock is multi-family units and the percentage of mobile homes is 9.5%. Regarding building stock age, 42.7% of residential structures were constructed since 1990, comparable to the county average of 37.9%. See Appendix B: Community Profile for additional demographic, economic, and building information.

The presence of a hospital and other health care facilities allows the city to mobilize care for people who may suffer injury from a catastrophic type of natural hazard event such as an earthquake.

Plans and Policies

The City of Lebanon's Comprehensive Plan was first acknowledged by the Oregon Land Conservation and Development Commission in 1980. The City last amended the plan in 2004. Section 2 covers aspects of Statewide Planning Goals 5, 6, and 7. The City implements the plan through the Lebanon Municipal Code, which was last revised in 2024.

Lebanon currently has the following plans that relate to natural hazard mitigation. These documents are available online for review or by request. The Emergency Operations Plan is maintained by the Police Department.

- Comprehensive Plan (1980, amended December 2004)
- Housing Production Strategy (2023)
- Lebanon Municipal Code (July 2024 revision)
    - 16.11.070 - Floodplain overlay zone
- Lebanon 2040 Vision and Community Strategic Action Plan (April 2016)
- Storm Drainage Master Plan (2022)
- Transportation System Plan (2018, Vol. 1 and Vol. 2)
- Water Management and Conservation Plan (2015)
- Emergency Operations Plan

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's mitigation strategy. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city has identified mitigations actions that will help to increase Lebanon's overall mitigation capability.

Hazard Profile

The DOGAMI Multi-hazard Risk Assessment analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the following tables. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table LB-1. City of Lebanon Hazard Profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Lebanon		20,320	8,789		29	2,688,032,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	1,425	7.0%	2,092	3	333,797,893	12%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	1,422	7.0%	1,895	6	360,458,752	13%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	6	0%	7	0	826,000	0%
Wildfire	High and Moderate Risk	523	2.6%	153	1	54,052,000	2.0%

[1]Facilities with multiple buildings were consolidated into one building complex.
[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).
Source: DOGAMI Multi-Hazard Risk Report, 2024

Table LB-2. City of Lebanon Critical Facilities

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Cascades School	-	X	X	-	-
Green Acres School	-	-	-	-	-
LBCC Advanced Transportation Technology Center	-	-	X	-	-
LBCC Lebanon Center	-	-	-	-	-
Lebanon City Hall	-	-	-	-	-
Lebanon City Storage	-	-	-	-	-
Lebanon Fire District - Station 31	-	-	-	-	-
Lebanon Fire District Station 34	-	-	-	-	-
Lebanon High School*	-	-	-	-	-
Lebanon Maintenance Training Bay	-	-	-	-	-
Lebanon Police Department	-	-	-	-	-

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Lebanon State Airport	-	-	-	-	-
Lebanon Wastewater Treatment	-	-	X	-	-
Linn County Sheriff's Office – Lebanon Substation	-	-	-	-	-
Montessa Pump Station	-	-	-	-	-
Oregon Army National Guard	-	-	-	-	-
Park Drive Pump Station	-	-	-	-	-
Pioneer School	-	-	-	-	-
Riverview Elementary School	-	-	-	-	X
Samaritan Lebanon Community Hospital - East Linn Health Clinic	-	-	-	-	-
Samaritan Lebanon Community Hospital	-	-	-	-	-
Sand Ridge Charter – South Main Campus	-	-	-	-	-
Seven Oak Middle School	-	-	-	-	-
Water Treatment Plant	-	-	-	-	-
Western University COMP Northwest	-	-	X	-	-
Western University Health Sciences University	-	X	X	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.
Source: DOGAMI Multi-Hazard Risk Report, 2024

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the jurisdiction representatives first updated the description, type, location, and extent of each hazard. Next, they updated the Hazard Analysis Methodology based on each hazard's potential impact on the county as a whole. The results of that exercise are provided in Table LB-3**.**

In this analysis, severity ratings and weight factors are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2, Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

This method provides the City of Lebanon with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one

hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The City of Lebanon representatives refined the risk assessment with guidance provided by the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table LB-4, below, represents the relative risk to the natural hazards as experienced in the City of Lebanon representatives compared to the county level ranking completed by the Steering Committee.

Winter Storm, which was revised in 2024 to include Ice Storms, retains the top-ranking hazard for the county and City of Lebanon representatives. Extreme Heat and Smoke/Poor Air Quality, both newly identified hazards in this update, also rank most highly for the City.

Crustal Earthquake and CSZ events are of greater concern to the City of Lebanon than is Wildfire. The impact of Windstorms in Lebanon was a ranked as a middle-tier natural hazard by City staff.

Drought has become a greater concern for the City of Lebanon than it had been in the past. The county's ranking of Drought increased since the last NHMP risk assessment exercise was conducted in 2016.

Dam Failure was considered in light of the areas supported by berms along the Santiam-Albany Canal that may pose the risk of flooding should they weaken and rupture.

Table LB-3. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table LB-4. Relative Risks of Natural Hazards in Lebanon

	Total Score	
HAZARD	**County**	**Lebanon**
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	same or ↓
Drought	169.0	same
Earthquake (Cascadia)	160.7	same
Wildfire	158.9	↓
Earthquake (Crustal)	155.7	↑
Dam Failure	133.8	same or ↑
Windstorm/Tornado	116.5	↑
Volcano	109.0	↑
Landslide and Avalanche	106.4	same

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Lebanon. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Lebanon Hazard Profile and Critical Facilities tables (LB-1 and LB-2) included above, this section identifies vulnerabilities specific to Lebanon, recent localized hazard events and impacts, and illustrates the basis for the city's HVA scores.

Dam Failure

Events: None

Vulnerability and Impacts: Dam failure was considered in light of the areas supported by berms along the Santiam-Albany Canal that may pose the risk of flooding should they weaken and rupture.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018, and 2021-2023.

Vulnerability and Impacts: The City's water supply, described above, may be susceptible to impacts from drought. The City is currently updating its Water Management and Conservation Plan. Drought can also impact tree health throughout the community, increasing the vulnerability of trees to other natural hazards, such as windstorms and winter storms, and potentially decreasing the canopy which provides cooling benefits to mitigate extreme heat.

Earthquake

Events: None

Vulnerability and Impacts: Older building stock, including unreinforced masonry buildings, is of concern. DOGAMI's analysis found that several schools in Lebanon, including Cascades School, Linn Benton Community College Advanced Transportation Technology Center, and two Western University facilities, and the Lebanon Water Treatment Plant are vulnerable to CSZ 9.0 and Turner and Mill Creek Fault 6.6 earthquakes. Several community lifeline facilities, including elder care facilities, food distribution facilities, the community center, communications facilities, and financial institutions, were identified by DOGAMI as being susceptible to earthquake damage.

Extreme Heat

Events: June and August 2021

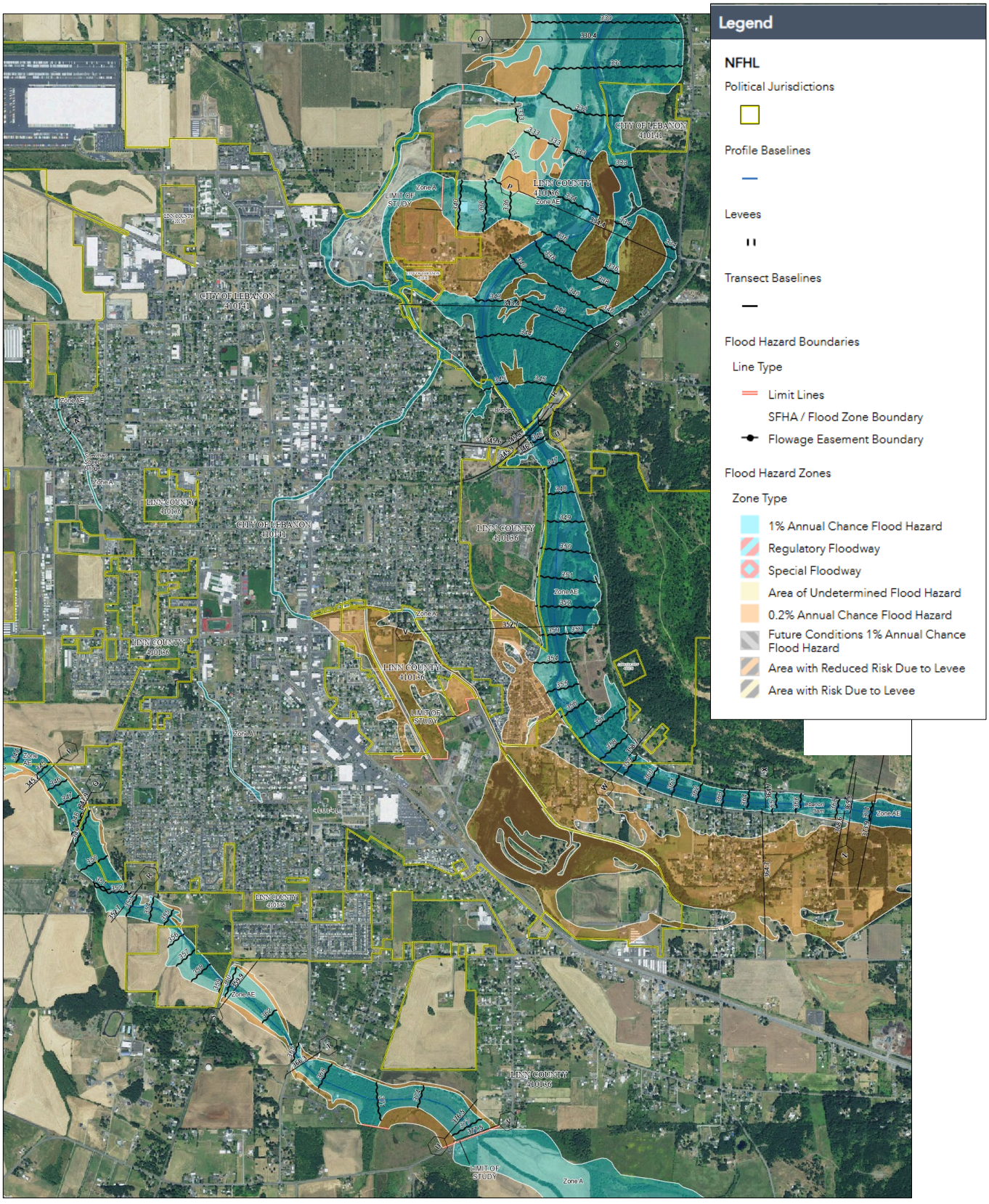
Vulnerability and Impacts: People in need of cooling centers were directed to Lebanon and Albany during the 2021 heat dome. Both the Lebanon Library and Senior Centers are equipped with air conditioning and serve as shelters for extreme heat. The heat limited the ability of City crews and staff to do outside work.

Flood

Events: In September 2020, minor street flooding occurred from a severe thunderstorm that developed southeast of Salem during the overnight hours of September 17-18.

Vulnerability and Impacts: There are areas along the Santiam-Albany Canal that may weaken and be the source of flooding; see the following figure for locations of flood hazard zones in Lebanon.

Figure LB-2. Special Flood Hazard Area in Lebanon



Source: [FEMA's National Flood Hazard Layer (NFHL) Viewer]

Landslide/Avalanche

Events: None

Smoke/Poor Air Quality

Events: 2020 event affected the city for a week or more

Vulnerability and Impacts: The smoke limited the ability of city employees to do their jobs, including driving around the city.

Volcano

Events: None

Wildfire

Events: 2020 wildfires were more of a smoke event rather than posing risk from wildfire.

Vulnerability and Impacts: The smoke in 2020 limited the ability of city employees to do their jobs, including driving around the city. Riverview Elementary School was identified in the DOGAMI report as being exposed to Moderate or High wildfire risk.

Winter Storm/Ice Storm

Events: Several events, none notable.

Vulnerability and Impacts: Power lines and trees.

Windstorm/Tornado

Events: No notable events.

Vulnerability and Impacts: Power lines and trees.

Mitigation Strategy

During the 2023-2024 Linn County and Lebanon update process, the DLCD planner and Lebanon representatives assessed the mitigation strategy actions within the 2017 Lebanon Addendum. Together they revised and updated that list of actions to reflect the revised risk assessment for Lebanon.

Table LB-5. Completed Actions - Lebanon

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Pool #3	Drought	Identify incentive programs to install water efficient devices in existing and new city owned facilities.	Planning, Administration	Short-Term	Completed	
Pool #5	Flood	Update applicable City codes and ordinances to improve risk reduction and prevention of flood impacts by increasing the base flood elevation standards from 1 foot to 2 feet in height.	Planning, Parks and Recreation	Ongoing	Completed	City updated code to OR model code.
Pool #6	Severe Weather (Winter Storm/ Windstorm)	Coordinate with the local utility to identify any power lines that could be placed underground to prevent power outages from wind and winter storms.	Planning, Public Works	Short-Term	Completed	Revised development code to require undergrounding utilities in new construction; State law now compels power companies to underground new lines.

Table LB-6. Actions Removed from the Lebanon Addendum

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Priority #3	Multi-Hazard	Provide NHMP awareness training to City staff to incorporate Natural Hazard Mitigation Planning aspects into their daily work.	Planning, Emergency Management, Fire, Police	Ongoing	Remove	May be part of new EOP update
Priority #5	Drought	Support local agency programs that promote measures to reduce water use during drought emergencies.	Emergency Management, Planning, Administration	Ongoing	Remove	City may initiate curtailment should drought affect the city. The city currently tracks water use and a water conservation management plan is in place. The city does leak detection on the water system to reduce losses.
Priority #9	Flood	Complete an inventory of locations in city of Lebanon subject to frequent storm water flooding outside of designated floodplains.	Public Works, Planning	Short-Term	Remove	FEMA's SFHA map covers all areas that flood.
Pool #1	Multi-Hazard	Assist K-12 schools, childcare facilities and schools to develop vulnerability assessments and mitigation projects to improve safety.	Planning, Fire, Police, School District	Ongoing	Remove	This action is outside city's purview.
Pool #2	Multi-Hazard	Prepare residents to manage without power, utilities, or transportation during disaster event; communicate and promote readiness; build cooperative relationships with private businesses for assistance during disaster.	Emergency Management, Fire, Police, Planning	Ongoing	Remove	Combined with public education action and EOP outreach action
Pool #7	Wildfire	Host a Firewise Communities Workshop to increase mitigation concepts and partnerships.	Emergency Management, Fire	Ongoing	Remove	This is included in Linn County's CWPP, and the fire district participates in that. This action is not the role of the city.

Table LB-7. Ongoing, Short- and Long-Term Projects – Lebanon

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 1	Update emergency operations plan.	Planning, Administration	Ongoing	Retain	Grants or City	The current OEP is dated 2012 and the city intends to update it. When updated, provide information to city employees about the plan.
Multi-Hazard 2	Develop public education efforts about the natural hazards Lebanon is vulnerable to and mitigation measures residents can implement.	Planning, Administration	Ongoing	Retain	City	City is discussing how to improve communication channels and including communications about natural hazard mitigation measures is part of that discussion. Considering how to inform residents about how to manage without power, utilities, or transportation during disaster event. Considering how to promote readiness with public information communications.
Multi-Hazard 3	Create or update a Continuity of Operations Plan (COOP).	Planning, Emergency Management, Fire, Police	Short-Term	Retain	Grants	
Drought 1	Update the 2015 Water Management and Conservation Plan (WMCP).	Public Works, Administration, Planning	Short term; progressing	Retain, revised	City	City is currently updating this plan.
Earthquake 1	Develop educational materials on nonstructural and structural earthquake mitigation measures.	Fire, Police, Emergency Management, Planning	Ongoing	Retain, revised	Grants or City	The city would be looking to partner with BCD or OEM to identify any existing materials that could be utilized

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Earthquake 2	Seek grant funding for seismic retrofitting of city-owned inventoried critical infrastructure or facilities.	Planning, Public Works, Emergency Management	Short-Term	Retain, revised	Grants	DOGAMI's inventory of critical facilities can be the basis for this mitigation strategy. Due to the ownership of some of those facilities, such as the schools, the city can only advise. Note the HS has been partially retrofitted.
Earthquake 3	Seek funding alternatives to seismically retrofit the water system as identified in city evaluation of the system.	Planning, Public Works	Long-Term	Progressing, revised	Grants	City is constantly looking for funds to complete planned upgrades planned for the system. These upgrades are part of the considerations for the yearly budget cycle.
Flood 1	Ensure continued compliance in the National Flood Insurance Program (NFIP) through enforcement of the provisions of flood damage prevention in the Lebanon Development Code.	Planning, Public Works, Administration	Ongoing	Retain	n/a	This is not a funding source item, but a code compliance item. The city will stay informed of all FEMA and NFIP related changes and updated the city's ordinances accordingly.
Flood 2	Work with the county to mitigate areas within the city's UGB that experience repetitive flooding and significant damages or road closures.	Public Works, Planning	Long-Term	Retain, revised	Linn County	Areas identified include Oak Creek where it floods within the city's UGB and at the intersection of Vaughn Ln. and Stoltz Hill Rd. where high water can overtop the road.

Plan Implementation and Maintenance

The City Council is responsible for adopting the Linn County MJ-NHMP including the City of Lebanon Addendum to the Linn County MJ-NHMP. The Engineering Services Director is responsible for coordinating implementation and maintenance of the Lebanon Addendum to the Linn County MJ-NHMP and will participate in the Linn County MJ-NHMP implementation and maintenance meetings. The Lebanon representative will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of Lebanon's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. Lebanon is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, Lebanon will also review and update its addendum. The Lebanon convener will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Lebanon's convener determine what components of the mitigation plan need updating.

CITY OF LYONS ADDENDUM

Purpose

This document serves as the City of Lyons's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by Lyons to improve the resilience of the community. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the information contained in Volume I (Basic Plan) of this NHMP which serves as the plan foundation and Volume II which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

Prior to this update, Lyons has participated in a natural hazard mitigation planning process and has a pre-existing addendum to the Linn County NHMP.

During 2023 and 2024 Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities, including Lyons, to update their addendum to the Linn County Natural Hazard Mitigation Plan, which expired May 23, 2023.

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the City of Lyons will regain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Lyons joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on 2/12/2024. On 2/7/2024, 3/13/2024, 4/3/2024, and 10/23/2024, Micki Valentine, Lyons City Manager, participated in meetings facilitated by DLCD, including conducting a risk assessment exercise with other county jurisdictions that included a Hazard Vulnerability Assessment ranking. City staff met again with DLCD on 7/29/2024, to update this addendum.

Lyons staff promoted the NHMP survey and outreach efforts throughout the plan update, including public posts on the City's website and Facebook page on August 29, 2024, to distribute the plan update public survey to interested parties in and around Lyons.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Lyons Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Lyons Addendum, are the result of a collaborative effort between residents, public agencies, non-profit organizations, the private sector, and regional organizations, and public officials. Lyons's City Manager guided the process of developing the plan and engaged the Public Works Director, City Council members, and the Mayor during the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary sections, and Planning and Public Process (Appendix A).

The Lyons City Manager is the designated Convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The City Manager and the DLCD project manager revised the Lyons Addendum with particular focus on the specific hazard history, risk assessment, and mitigation strategy for the City of Lyons. During the update process city staff and other participants provided additional information on potential funding sources, action item prioritization, local resource and capacity restraints.

The City of Lyons advisory group included the following individuals:

- Micki Valentine, City Manager
- Lloyd Valentine, Mayor
- Jessica Ritchie, Pro Tem
- Mike Wagner, Councilor
- Diane Hyde, Councilor
- Amy Thrasher, Councilor
- Richard Berkey, Public Works

Lyons staff used multiple approaches to engage the public. City staff also presented the draft plan to the City Council during an open public council session. The City Council was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. The City also participated in countywide community engagement activities described in Volume I, Section 4 and in Appendix A

The Convener for Lyons will also remain active in the county's implementation and maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[20] This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards*.

[20] 44 CFR 201.6(2)(i)

Community Profile

This section provides information on city specific assets and populations. For additional information on the characteristics of Lyons, in terms of geography, environment, population, demographics, employment and economics, housing, and transportation see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

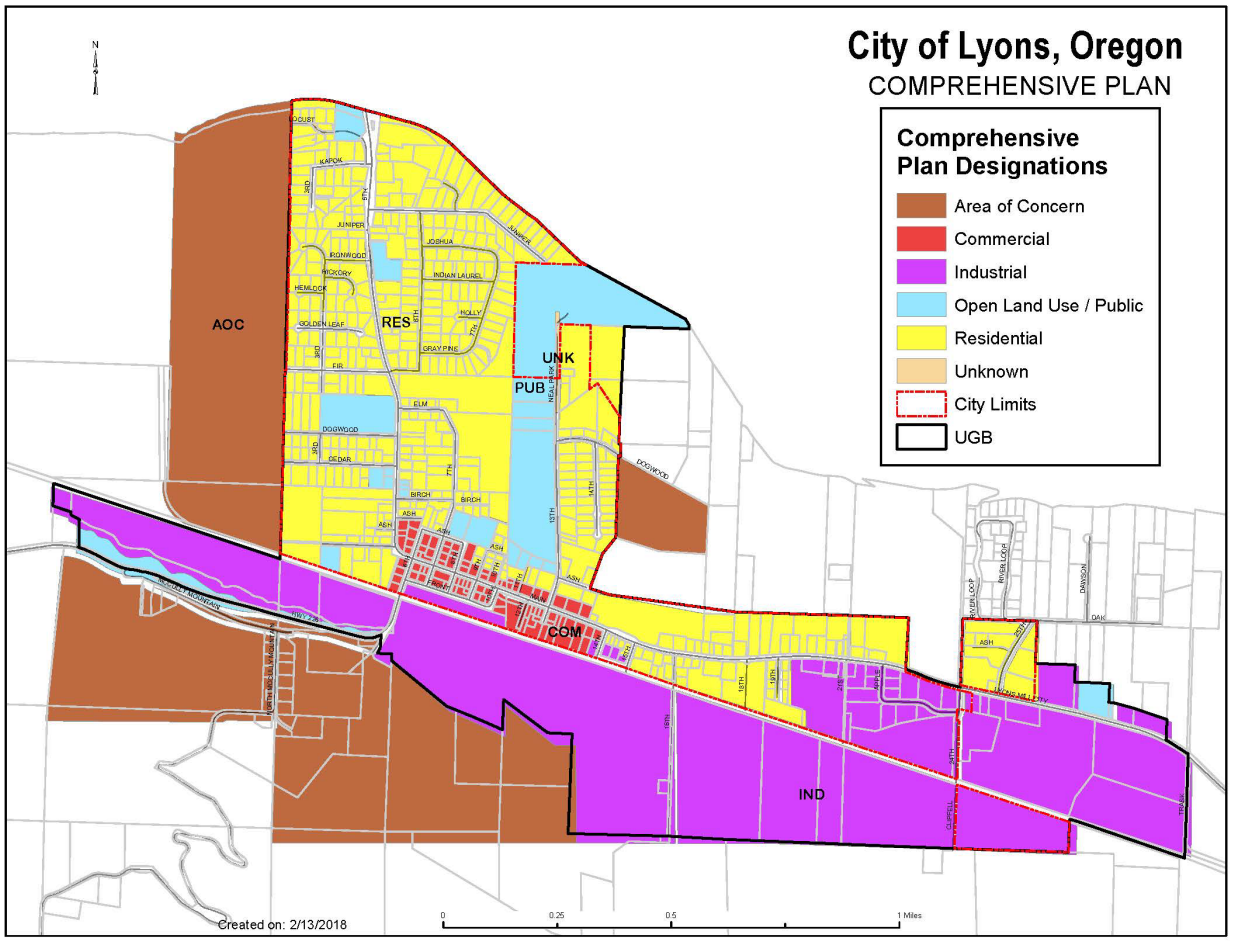
Lyons is located in Linn County, approximately 26 miles southeast of Salem and 32 miles northeast of Albany. Lyons was founded in 1880 and legally incorporated in 1958. It occupies an area of 0.88 square miles (563.2 acres). Lyons experiences a moderate climate. In August, the average high temperature is 74°F, and the average low temperature is 49°F. Wintertime temperatures in January range from an average high of 42 degrees, and an average low of 33°F. Lyons receives an average annual precipitation of 56 inches.

The North Santiam River runs along the northern boundary of Lyons. Several small ponds are surrounded by county and municipal parkland near the eastern edge of town. Trask Creek collects drainage from the southern hills along the south edge of the city. Lyons is located on mostly flat land, with elevations increasing slightly on the south side of town, with ridges surrounding Lyons to the south and northeast. The unincorporated community of Mehama is located on the north bank of the North Santiam River across from Lyons. The landscape surrounding Lyons consists of farmland in level areas, and forestland on surrounding slopes.

The Population Research Center at Portland State University lists Lyons's 2023 population at 1,203. This represents a minimal decrease from 2020 (1,207) and small increase from 2015 (1,160). The median age in Lyons is 55, and it is one of the cities in Linn County with the greatest number of residents over 64 per hundred residents potentially in the workforce, also known as the Old-age Dependency Ratio. For more demographic information, refer to Appendix B.

Historically, Lyons was a timber community. Now, about 85% of the labor force in Lyons is employed in manufacturing and services. Lyons also serves as a bedroom community for major employers in the surrounding area. The median household income in Lyons in 2022 was $94,250 based on US Census ACS 5-year estimates, the third highest in Linn County. 85.4% of the houses in Lyons are single family units, the second highest in the county. Since 2015, there has been a 13% decrease in the number of mobile homes in Lyons. For more economic and housing information, refer to Appendix B.

Figure LY-1. City of Lyons Comprehensive Plan Map



Source: City of Lyons Comprehensive Plan Appendix B (codepublishing.com)

Critical and Important Facilities

Lyons's critical and important facilities include the following:

- Lyons City Hall, 449 5th St.
- Lyons City Shop, 725 N 13th St.
- Lyons Rural Fire Protection District Station 550, 1114 Main St.
- Lyons-Mehama Water District, 442 Locust St.
- Mari-Linn Elementary School, 643 5th St.

The City also identified the Lyons Public Library and Lyons Post Office as important community lifeline facilities in Lyons. City representatives also identified the Linn County Sheriff's office and the facilities of private power companies and fuel suppliers (Pacific Power, NW Natural Gas, and PC Energy Fuel Station) as important facilities located near Lyons.

City representatives specifically identified Santiam Valley Grange, Santiam Chapel, Canyon Bible Fellowship, and St. Patrick's Church & Hall as providing essential support for response and recovery efforts. Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline

Risk by Linn County Community for more information. The DOGAMI analysis identified high-occupancy buildings, a post office, and churches.

Transportation

Main transportation corridors to and from Lyons include Highway 226, which connects with Highway 20 to provide the main access to and from Albany, located to the southwest. Highway 22 to the north provides east/west access to and from Stayton to the west, and Salem to the northwest. Highways 22 and 226 provide connectivity to I-5. Highway 226 intersects with Highway 22 just north of Lyons, in Mehama, located on the north bank of the North Santiam River. East Lyons Mill City Drive diverges from Highway 226 in downtown Lyons and provides an additional east/west connection to Mill City, located 8 miles to the east. The North Santiam River Bridge between Lyons and Mehama forms the only connection between the two communities. Without an operational bridge, Lyons would have no access to Mehama or Highway 22.

Albany and Eastern Railroad Company (AERC) owns and operates the Mill City District railroad line, a railway that runs from Mill City to Lebanon and forms the southern boundary of Lyons. This railroad provides railroad transport to industrial sites in Lebanon and Albany.

Road	Owner	Notes
OR-22	ODOT	East/West route across the N. Santiam River from the city
OR-20	ODOT	East/west route to Albany
OR-226	ODOT	North/South route that connects to both OR-20 and OR-22
Rail line	AERC	Mill City District railroad line between Mill City and Albany via Lyons and Lebanon

Cherriots is the public transit provider for Salem, Keizer, and the mid-Willamette Valley. The Cherriots Regional 30X bus stops at the Lyons Fire Station, providing transportation to and from Salem, Stayton, Mill City, and Gates.

Energy

Pacific Power supplies electricity to the Lyons. NW Natural Gas provides gas to the community. Lyons RFPD has an automatic backup generator for their facility. City-owned buildings do not have backup generators, but these are needed.

Water/Wastewater

The Lyons-Mehama Water District has a water storage capacity of approximately 1,850,000,000 gallons supplied by two storage reservoirs. There is additional water capacity available as needed from the Big Cliff Reservoir, located approximately 3 miles downstream from Detroit Lake.

There is no sanitary sewer system in Lyons. All properties are served by their own onsite septic system.

Emergency Services

The Linn County Sheriff provides police services. The Lyons Rural Fire Protection District provides fire and ambulance services.

Vulnerable Populations and Plans and Policies

Functional and Access Needs of Vulnerable Populations

Based on US Census American Community Survey estimates the percentage of people living in poverty in Lyons has worsened overall and also for those under 18 years old in particular. Poverty for children has significantly worsened in Lyons moving from 15% to in 2015 to 39.2% in 2022. The average age of residents of Lyons is among the highest in Linn County, reflecting an aging population relative to other cities in the county. On the other hand, in 2022 median household income was among the highest in the county. For more demographic and economic information, see Appendix B.

The city is home to one elementary school, Mari-Linn Elementary School, which serves elementary school students living in and around Lyons.

Plans and Policies

The Lyons Comprehensive Plan was first acknowledged by the Oregon Land Conservation and Development Commission in 1980. The City last amended the plan in 2003. Lyons last updated Chapter 903, which includes information pertaining to Statewide Planning Goal 7, Natural Hazards, in 2011. The City implements the plan through the City of Lyons Municipal Code, which was last revised May 28, 2024.

Lyons currently has the following plans that relate to natural hazard mitigation. These documents can currently be viewed through the City's website:

- Comprehensive Plan (2003)
- Municipal Development Code (January, 2021)
    - Flood Damage Prevention
- City Storm Drainage Plan (May, 2011) and Street Storm Drain Design Standards (2021)

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's mitigation strategy. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city has identified mitigations actions that will help to increase Lyons' overall mitigation capability.

Hazard Profile

The DOGAMI Multi-hazard Risk Assessment analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the following tables. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table LY-1. City of Lyons Hazard Profile

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Lyons	1,203	1,074	5	223,889,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	11	0.9%	6	0	70,000	0%
Earthquake	CSZ Mw-9.0 Deterministic	23	1.9%	126	1	12,905,823	5.8%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	20	1.7%	75	1	9,900,919	4.4%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	8	0.6%	6	0	1,185,000	0.5%
Channel Migration	Channel Migration Zone	22	4.7%	22	0	8,509,000	3.8%
Wildfire	High and Moderate Risk	188	16%	194	0	31,971,000	14%
Volcanic Lahar	1% Annual Chance	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Source: DOGAMI Multi-Hazard Risk Report, 2024

Table LY-2. City of Lyons Critical Facilities

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Volcanic Lahar - 1% Annual Chance
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed	Exposed
City of Lyons Shop	-	-	-	-	-	-	-
Lyons City Hall	-	-	-	-	-	-	-
Lyons RFD - Station 550	-	-	-	-	-	-	-
Lyons-Mehama Water District Shop	-	-	-	-	-	-	-
Mari-Linn Elementary School	-	X	-	-	-	-	-

Source: DOGAMI Multi-Hazard Risk Report, 2024

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, jurisdiction representatives first updated the description, type, location, and extent of each hazard. Next, they updated the Hazard Analysis Methodology based on each hazard's potential impact on the county as a whole. The results of that exercise are provided in Table LY-3, below.

In this analysis, severity ratings, and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2, Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the Lyons and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

This method provides the jurisdictions with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The City of Lyons representatives refined the risk assessment with guidance from the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table LY-4, below, represents the variation in total risk to the natural hazards as experienced by City of Lyons representatives compared to the county level ranking completed by the Steering Committee.

Winter Storm, which was revised in 2024 to include Ice Storms, retains the top-ranking hazard for the county and the city. The January 2024 ice storm (DR-4768) had an impact on trees in Lyons and related tree maintenance and removal. Extreme Heat, Smoke/Poor Air Quality, both newly identified hazards in this update, and Windstorms rank most highly for the City of Lyons staff. The impact of windstorms on tree mortality was identified by City staff.

The City of Lyons ranks Wildfire risk higher than Earthquake, but lower than the risk of damage from Windstorms. The maximum threat to the City of Lyons from Wildfire caused the City representatives to rank it as a High level hazard, higher than it was ranked for the county as a whole. The frequency of Windstorms in Lyons is greater than experienced overall in the county. Drought has become a greater concern for the City of Lyons than it had been in the past. The county's ranking of Drought increased since the last NHMP risk assessment exercise was conducted in 2016.

The City does not consider Volcano or Dam Failure to be hazards that require mitigation action by the City and will not identify mitigation actions for those hazards.

Table LY-3. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table LY-4. Relative Risks of Natural Hazards in Lyons

	Total Score	
HAZARD	**County**	**Lyons**
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	same
Drought	169.0	same
Earthquake (Cascadia)	160.7	same
Wildfire	158.9	↑
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	n/a
Windstorm/Tornado	116.5	↑↑
Volcano	109.0	n/a
Landslide and Avalanche	106.4	same

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Lyons. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Lyons Hazard Profile and Critical Facilities tables (LY-1 and LY-2) included above, this section identifies vulnerabilities specific to Lyons, recent localized hazard events and impacts, and illustrates the basis for the City's HVA scores.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018 and 2021-2023.

Vulnerability and Impacts: The City of Lyons is beginning to see the effects of drought through declines in tree health, sometimes resulting in death of the tree which then needs to be removed.

Earthquake

Events: None.

Vulnerability and Impacts: The Mari-Linn Elementary School, which serves students in grades K-8 and is part of the North Santiam School District, is vulnerable to a CSZ 9.0

Earthquake. A community lifeline high-occupancy building was also found to be vulnerable to a CSZ 9.0 earthquake.

Extreme Heat

Events: Excessive heat and high heat events in 2017, 2021, and 2022.

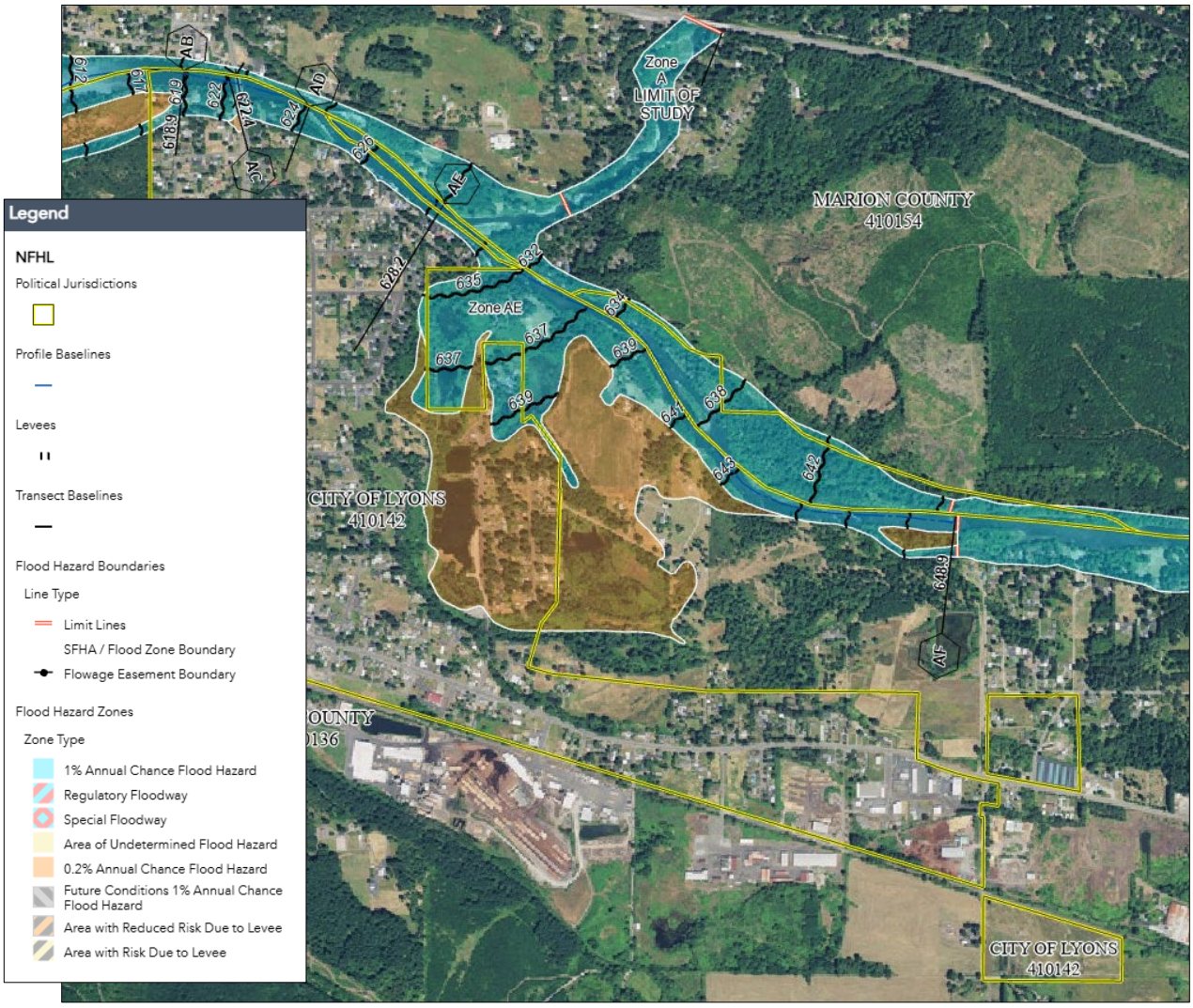
Vulnerability and Impacts: The City has not yet identified a building that could serve as a refuge for those who need a cool place to go during extreme heat events.

Flood

Events: None.

Vulnerability and Impacts: The North Santiam River is highly susceptible to stream channel migration. Structures near and within these floodplains, shown in the following figure, are at high risk from channel migration hazard.

Figure LY-2. Special Flood Hazard Area in Lyons



Source: [FEMA's National Flood Hazard Layer (NFHL) Viewer]

Landslide/Avalanche

Events: None

Vulnerability and Impacts: Areas along Highway 22 along the North Santiam River have a high level of exposure to landslide hazard. While Highway 22 is not in Lyons, it provides important transportation access.

Smoke/Poor Air Quality

Events: Annual field burning season periodically is exacerbated by wildfire smoke that enters the valley sometimes from outside the county.

Vulnerability and Impacts: The geography of the Santiam canyon causes air currents to funnel through the City of Lyons.

Volcano

Events: None

Vulnerability and Impacts: Lyons is one of the communities threatened by a volcanic lahar event, along with Gates and Mill City. However, no buildings were found by DOGAMI to be at risk.

Wildfire

Events: The catastrophic 2020 Lionshead/Beachie Creek wildfire burned to the northern bank of the North Santiam River and greatly impacted the north part of Linn County, including Lyons and the surrounding areas. In addition to the direct impacts from the fire, people were affected by evacuations, smoke, and road and area closures, impacting public health, recreation, and local economies.

Vulnerability and Impacts: Firefighting capacity was compromised due to electricity shutoff resulting in water pumps failing to resupply firefighting equipment. In addition, limited or undelivered notice of the evacuation order and lack of confidence that evacuation would leave property safe from vandalism and vigilante activities left residents of Lyons highly vulnerable to both the wildfire and to related risks. A community lifeline high-occupancy building was found to be vulnerable to Moderate and High wildfire risk per DOGAMI's analysis.

Winter Storm/Ice Storm

Events: Several winter storms affected the City of Lyons since 2017, in particular the ice that accompanied the December 22, 2022, winter storm. Several winter storms and notable ice storm in February 2021 (DR-4599) and January 2024 (DR-4768) affected the county.

Vulnerability and Impacts: The most common vulnerability to winter storms is the trees that can be impacted or brought down. This can result in downed power lines also.

Windstorm/Tornado

Events: Windstorm events in 2017, 2018, 2020, 2022, and in 2023. The September 7, 2020, event resulted in rapid growth of wildfires. The December 27, 2022, event resulted in peak gusts up to 60 mph in Lyons.

Vulnerability and Impacts: There are similar vulnerabilities to winter storms, downed trees and power lines.

Mitigation Strategy

During the 2023-2024 Linn County and Lyons update process, the DLCD planner and Lyons representatives assessed the mitigation strategy actions within the 2017 Lyons Addendum. Together they revised and updated that list of actions to reflect the revised risk assessment for Lyons.

Table LY-5. Completed Actions - Lyons

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Priority #7	Earthquake	Complete inventory of critical facilities that are vulnerable to earthquake damage.	Planning, Public Works, Emergency Management	Short-Term	Complete	DOGAMI Multi-hazard Risk Assessment provides this inventory. Only one facility listed is vulnerable to damage from earthquake, the Mari-Linn Elementary School.

Table LY-6. Actions Removed from the Lyons Addendum

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Priority #8	Flood	Complete an inventory of locations in city of Lyons subject to frequent storm water flooding outside of designated floodplains.	Public Works, Planning	Short-Term	Remove	There are no areas that flood which are not identified as FEMA floodplains.
Priority #4	Multi-Hazard	Provide NHMP awareness training to City staff to incorporate Natural Hazard Mitigation.	Planning, Administration	Ongoing	Remove	This action is not useful to the city. Information about the EOP when it is updated would be more useful to city staff in the event of a natural hazard event.

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Pool #3	Multi-Hazard	Provide NHMP awareness training to City staff to incorporate Natural Hazard Mitigation Planning aspects into their daily work.	Administration, Emergency Management, Fire, Police	Ongoing	Remove	Duplicate of Priority #4 action which was removed.
Pool #7	Severe Weather (Winter Storm/ Windstorm)	Develop and implement landscaping and tree standards to keep trees from threatening lives, property, and public infrastructure.	Planning, Public Works	Short-Term	Remove	There is little appetite for additional regulation and the resulting enforcement.
Pool #5	Earthquake	Evaluate Lyons' water distribution system and seek funding alternatives to seismically retrofit where appropriate.	Planning, Public Works	Long-Term	Remove	Lyons does not operate a water system
Priority #5	Drought	Provide information regarding droughts and other natural hazards on the City's website. Provide hard copies at Lyons City Hall.	Public Works, Administration, Planning	Ongoing	Remove	Combined with other public information actions.
Pool #4	Drought	Identify incentive programs to install water efficient devices in existing and new city owned facilities.	Planning, Administration	Short-Term	Remove	Combined with other public information actions.

Table LY-7. Ongoing Actions, Short-, and Long-Term Projects – Lyons

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 1	Continue public education efforts aimed at informing citizens of the natural hazards Lyons is vulnerable to and mitigation measures residents can take independently to protect new and existing property. Specifically provide information about drought and water efficient devices to mitigate the impacts of drought	Planning, Fire, Police	Ongoing	Retain; revised to incorporate other similar actions	City General fund.	This action is similar to Priority #5 and Pool #4 from 2017. The city currently uses its website, an electronic reader board, bulletin boards and code enforcement interactions to inform residents about natural hazards.
Multi-Hazard 2	Support the school district if they want to develop vulnerability assessments and mitigation projects to improve safety.	Planning, Fire, Police, School District	Ongoing	Retain, revised	City General fund.	
Multi-Hazard 3	Provide information to residents about how to manage without power, utilities, or transportation during disaster event.	Emergency Management, Fire, Police, Planning	Ongoing	Retain; revised	City General fund.	The city works to communicate with residents, to promote readiness, and to build cooperative relationships with private businesses for assistance during disaster.
Multi-Hazard 4	Create or update a Continuity of Operations Plan (COOP).	Planning, Emergency Management, Fire, Police	Short term; 1-3 years	Retain	City General fund.	The city staff is small; but should there be staff turnover, new staff should be informed of the COOP.

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 5	Update emergency operations plan.	Planning, Administration	Long term; >5 years	Retain	City General fund.	It is important to keep the EOP current, however capacity to update will need to be identified.
Earthquake 1	Advocate that ODOT assess the seismic stability of the 5th Street Bridge.	Fire, Police, Emergency Management, Planning, ODOT	Ongoing	Retain; revised	City General fund.	5th Street bridge is Potentially Vulnerable to damage from earthquake based on the ODOT 2023 Bridge Report.
Flood 1	Ensure continued compliance in the National Flood Insurance Program (NFIP) through enforcement of the provisions of Flood Damage Prevention in the Lyons Municipal Code.	Planning, Public Works, Administration	Ongoing	Retain	City General fund.	Site grading permits required for earthwork in a natural hazard area (floodplain, landslide, slope over 15%); zoning and/or site engineering review for development activity in mapped natural features or hazards (e.g. wetlands, riparian areas, geo-hazard areas and floodplain).
Flood 2	Encourage development of acquisition and management strategies to preserve open space for flood mitigation, fish habitat, and water quality in the floodplain and reduce risk to flood prone properties as well as preserve space for open space property.	Planning, Parks and Recreation	Ongoing	Retain	City General fund.	An area of apparently new construction is located in the 500-year Special Flood Hazard Area may be at risk of flooding in a rare event. The city staff noted concern with a small county bridge on 13th St that is the only way out of this neighborhood.

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Flood 3	For locations with repetitive flooding and significant damages or road closures, determine and implement mitigation measures such as upsizing culverts or storm water drainage ditches.	Public Works, Planning	Long term; >5 years	Retain	City Street fund, State and Federal grants, loans.	Storm water system upgrades will require significant support to city capacity to seek grants and then to manage them.
Wildfire 1	Participate with the county to implement wildfire actions in the Linn County Community Wildfire Protection Plan as they relate to Lyons.	Fire, Police, Emergency Management	Ongoing	Retain, revised	City General fund.	CWPP Action 2.1 regarding providing information about fire-resistant materials specifically refers to Lyons among other small cities in the county: "2.1 Collaborate with developers/builders, fire protection agencies, and relevant County agencies to collect and distribute educational materials regarding fire-resistant construction materials and techniques, fire code standards for access, water supply, fuel breaks, defensible space, and fire-resistant vegetation and landscaping in the WUI."

Plan Implementation and Maintenance

The City Council is responsible for adopting the Linn County MJ-NHMP including the City of Lyons addendum to the Linn County NHMP. The City Manager is the plan Convener and is responsible for coordinating implementation and maintenance of the Lyons Addendum to the Linn County MJ-NHMP and will participate in the Linn County NHMP implementation and maintenance meetings. The Lyons Convener will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of Lyons's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. Lyons is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, Lyons will also review and update its addendum. The Lyons Convener will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Lyons's Convener determine what components of the mitigation plan need updating.

LYONS RURAL FIRE DISTRICT ADDENDUM

Purpose

This document serves as the Lyons Rural Fire District's (Lyons RFD, Fire District) Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by the Lyons RFD to improve the resilience of the district. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the information contained in Volume I (Basic Plan) of this NHMP which serves as the plan foundation and Volume III (Appendices) which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

The Lyons RFD is incorporating its current effective NHMP into this 2025 update of the Linn County Multi-Jurisdictional Natural Hazard Mitigation Plan. The current Lyons RFD NHMP is effective until March 9, 2026, and will remain in effect until the Lyons RFD adopts the updated Linn County MJ-NHMP.

During 2023 and 2024 Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities and special districts, including Lyons RFD, to develop their addenda to the Linn County Natural Hazard Mitigation Plan

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the Lyons RFD will gain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The Lyons RFD joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on 12/17/2024. On 10/23/2024 Fire District Office Administrator Emily Hutchinson participated in Steering Committee meetings facilitated by DLCD with jurisdictions and districts joining the plan. Fire District staff met again with DLCD on 11/22/2024 to update this addendum, including discussion of the risk assessment and Hazard Vulnerability Assessment ranking and mitigation strategy review.

Lyons RFD staff promoted the NHMP survey and outreach efforts throughout the plan update.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Lyons Rural Fire District Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, including the Lyons RFD addendum, are the result of a collaborative effort between residents, public agencies, non-profit organizations, the private sector, and regional organizations. Public officials, including Lyons RFD's Fire Chief, EMS Coordinator, and Office Administrator, guided the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary sections, and Planning and Public Process (Appendix A).

The Lyons RFD Fire Chief is the designated convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The Fire Chief and the DLCD Project Manager revised the Lyons RFD Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the update process Fire District staff and other participants provided additional information on potential funding sources, action item prioritization, local resource and capacity restraints.

The Lyons RFD advisory group was comprised of the following individuals:

- Bob Johnston, Fire Chief
- Sherry Bensema, EMS Coordinator
- Emily Hutchison, Office Administrator

The Lyons RFD used multiple approaches to engage the public. Staff posted the link to the Linn County Natural Hazard Survey to learn what priorities the residents of Lyons RFD find most important. They also provided information to the public about the countywide process by posting links to the county's website for further information. The advisory group was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the advisory group were provided an opportunity for comment via the plan review process (see Appendix A for more information).

The convener for Lyons RFD will also remain active in the county's implementation and plan maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[21] This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards.*

Community Profile

This section provides information on specific Fire District assets and populations it serves. For additional information on the characteristics of Lyons, in terms of geography, environment, population, demographics, employment and economics, housing, and

[21] 44 CFR 201.6(2)(i)

transportation see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the Fire District specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

The Lyons RFD is governed by a Board of Directors. The Board of Directors consists of five members elected to staggered four-year terms by voters within the Fire District Service Area. The Board of Directors is responsible for identifying problems and opportunities within the Fire District and then addressing those issues through policy. The Board of Directors, in turn, hire a volunteer fire chief, who serves as the administrative head of the Fire District.

The Fire District is in Linn County, approximately 25 miles southeast of Salem and 30 miles northeast of Albany (Figure LFD-1). The Fire District was formed in 1954. The primary response area is 37 square miles including the City of Lyons, agricultural, and timber land (canyon and wilderness). The fire response area includes more than 1,200 residents. The Lyons Ambulance Service extends to about 1,000 square miles and includes the cities of Lyons, Mill City, Gates, and communities of Jordan, McCully Mountain, Mehama, Elkhorn, North Fork, Idanha-Detroit and parts of the cities of Stayton and Scio.

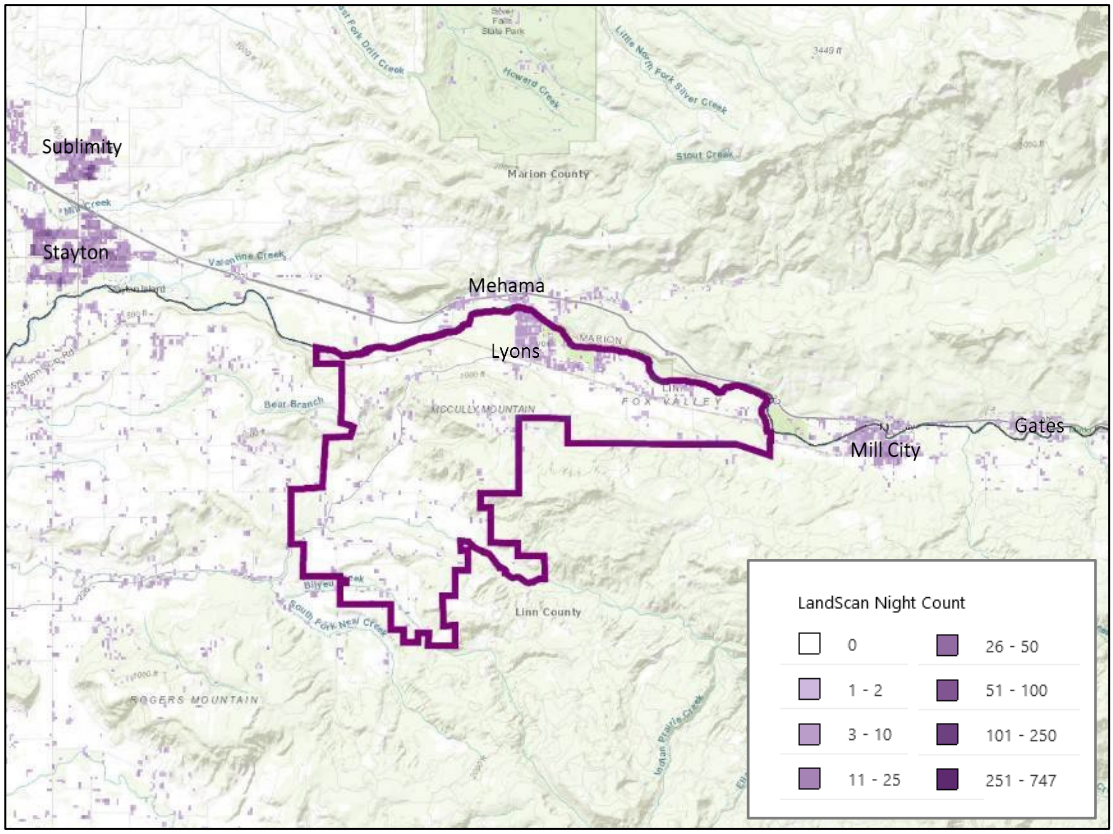
The Fire District experiences a moderate climate. Average monthly temperatures range from average lows of 32° - 36° Fahrenheit (F) (November through March) to average highs of 66° – 74°F (June through September). The driest months are July and August (average about 0.8 -1.0 inches of precipitation per month) and the wettest months are November through March (average about 8.25- 11.25 inches of precipitation per month). The average annual precipitation is 71.75 inches (76%, 54.9 inches falls November through April). Rain accumulation is higher in the hills within the fire district.

Temperatures have increased across Oregon by 2.2˚F in the period 1895–2015 (the observed record). In that same timeframe, Cascade Mountain snowpacks have declined, and higher temperatures are causing earlier spring snowmelt and spring peak streamflows. In Oregon's forested areas, large areas have been impacted by disturbances that include wildfire in recent years, and climate change is probably one major factor.

Climate models for Oregon suggest increases in temperature around 0.LFD-1°F per decade in the 21st Century, along with warmer and drier summers, and some evidence that extreme precipitation will increase in the future. By the 2050s Oregon is expected to see temperature increases between 3.6°F and 5.0°F depending on global emissions.[22]

[22] Oregon Climate Change Research Institute (OCCRI), 4th Oregon Climate Assessment Report (2019) and Northwest Climate Assessment Report (2013). http://www.occri.net/publications-and-reports/publications/

Figure LFD-1. Lyons Rural Fire District Service Area



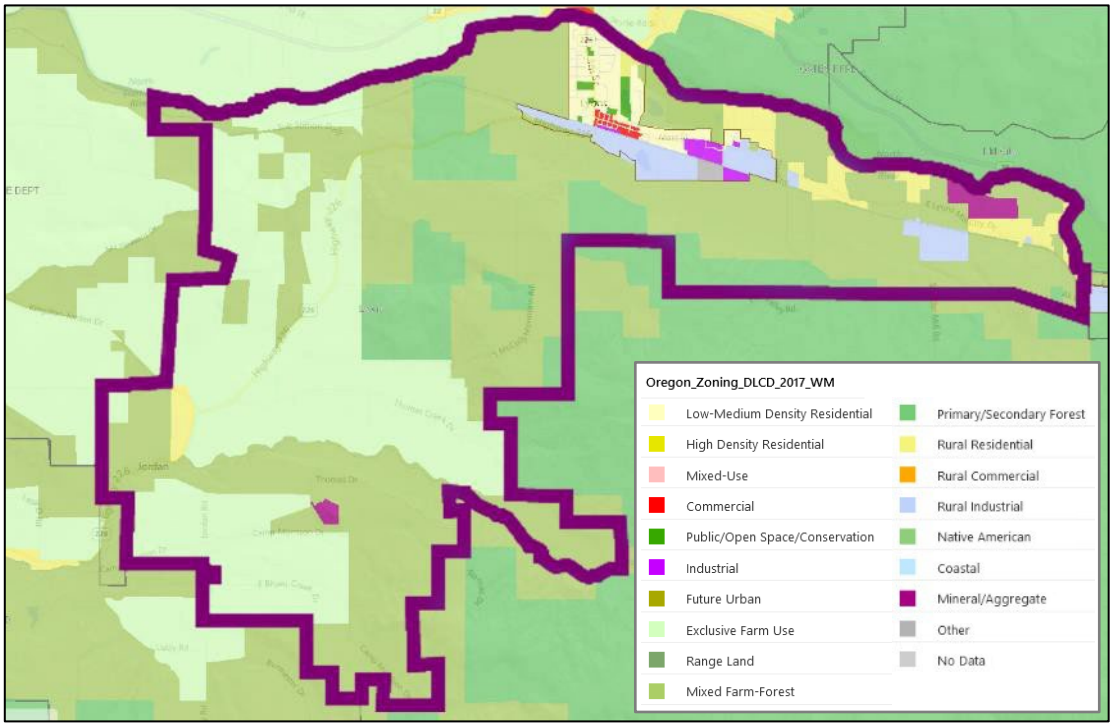
Source: Lyons Rural Fire Protection District NHMP, 2021.

The North Santiam River runs along the northern boundary of the Fire District, which encompasses mostly flat land, with elevations increasing slightly southwest of the City of Lyons at McCully Mountain (elev. 1,693 feet). Across the river to the north is the unincorporated community of Mehama, located on the north bank of the North Santiam River. The landscape outside of the City of Lyons consists of farmland in level areas and forestland on surrounding slopes.

The City of Lyons includes most of the population within the Fire District, as such the demographic information herein is for the City of Lyons and does not include population characteristics for other populated areas within the Fire District. The Population Research Center at Portland State University lists Lyons' 2023 population at 1,203. This represents a minimal increase from 2020 and an increase from 2015. For more demographic information, refer to Appendix B.

Development in the Fire District is mostly rural with more urbanized development within the City of Lyons. Commercial and industrial areas are along major roads and are centrally located. Figure LFD-2 shows the region's generalized zoning. New development has complied with the standards of the Oregon Building Code, and the Linn County and City of Lyons' development codes including their floodplain ordinances.

Figure LFD-2. Lyons Rural Fire District Generalized Zoning Map



Source: Lyons Rural Fire Protection District NHMP, 2021.

Historically, Lyons was a timber community. Now, about 85% of the labor force in Lyons is employed in manufacturing and services, including at Freres Engineered Wood which has facilities in Lyons and Mill City. Lyons also serves as a bedroom community for major employers in the surrounding area. The median household income in Lyons in 2022 was $94,250 based on US Census ACS 5-year estimates. For more economic information, refer to Appendix B.

Critical and Important Facilities

Critical and important facilities for the Lyons Fire District include the following:

- Lyons Rural Fire District Station 550, 1114 Main St., Lyons
- Lyons Rural Fire District Station 570, 39079 Jordan Rd., Scio

Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information.

Transportation

Main transportation corridors to and from the Fire District include Highway 226 and Highway 22, which both provide connectivity to Interstate 5. Highway 226 connects with Highway 20 to provide the main access to and from Albany, located to the southwest. Highway 22, the major east-west transportation route through the Fire District, connects the region to Salem and Central Oregon. The Oregon Department of Transportation has

identified Highway 22 as a Tier 2 seismic lifeline route, part of the network of streets, highways, and bridges intended to facilitate emergency services response after a disaster.[23]

Highway 226 intersects Highway 22 just north of Lyons, in Mehama, located on the north bank of the North Santiam River. East Lyons Mill City Drive diverges from Highway 226 in downtown Lyons and provides an additional east/west connection to Mill City, located 8 miles to the east. The North Santiam River Bridge between Lyons and Mehama forms the only connection between the two communities. Without an operational bridge, Lyons would have no access to Mehama, or Highway 22.

Mobility plays an important role in Linn County and the Fire District, and the daily experience of its residents and businesses. Motor vehicles represent the dominant mode of travel through, and within the Fire District. The area is also served by Cherriots public transit bus route 30x (Santiam/Salem Express), with service running six days a week with a stop in the Lyons. The bus stops at the Lyons Fire Station and provides transportation to and from Salem, Stayton, Mill City, and Gates.

Railroads are major providers of regional and national cargo and trade flows. Railroads run through the Willamette Valley region and provide a vital transportation link to the City of Lyons and the Fire District. The Albany and Eastern Railroad provides freight service to/from the City of Lyons and terminates in Mill City to the east and provides freight transport to industrial sites in Lebanon and Albany to the west. There is no passenger rail service in Lyons.

Rails are sensitive to icing from the winter storms that can occur in the region. For industries in the region that use rail transport, disruptions in service can result in economic losses. The potential for rail accidents caused by natural hazards can also have serious implications for the local communities if hazardous materials are involved.

Road	Owner	Notes
OR-22	ODOT	East/West route across the N. Santiam River from the city
OR-20	ODOT	East/west route to Albany
OR-226	ODOT	North/South route that connects to both OR-20 and OR-22
Rail line	AERC	Mill City District railroad line between Mill City and Albany via Lyons and Lebanon

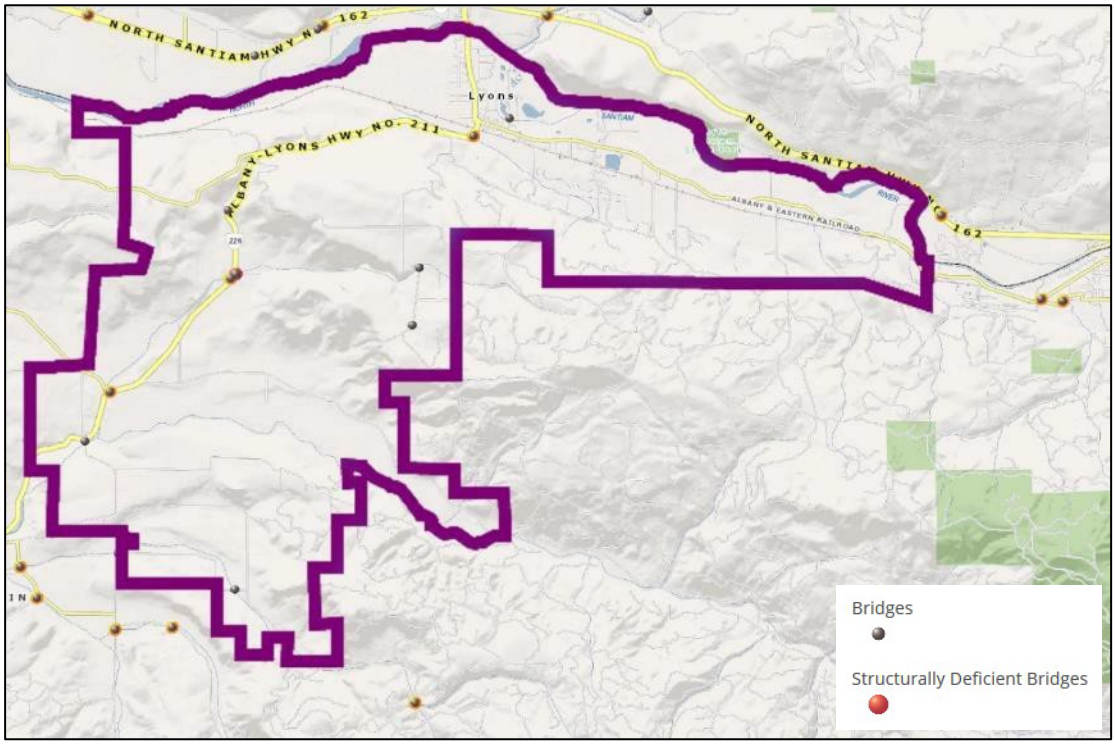
There are no public airports in the Fire District. The Davis Airport is the nearest general aviation airport, located about 10 miles east of the City of Lyons just south of the City of Gates. The nearest commercial airports are in Eugene and Portland.

Because of earthquake risk, the seismic vulnerability of the bridges within the Fire District boundary is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. Bridges within the Fire District

[23] Oregon Department of Transportation. Oregon Seismic Lifeline Evaluation, Vulnerability Synthesis, and Identification, *Oregon Seismic Lifeline Routes,* May 15, 2012.

are shown in Figure LFD-3. The Jordan Creek, Homestead Rd Bridge (ca. 1960), OR 226 (Bridge ID 14046) Bridge is considered structurally deficient (owned by Linn County).

Figure LFD-3. Oregon Bridges and Structurally Deficient Bridges in the Lyons RFD Area



Source: Lyons Rural Fire Protection District NHMP, 2021

Energy

Generally, the network of electricity transmission lines running throughout the Fire District is operated by Pacific Power (cities and along major transportation corridors) or Consumers Power (rural areas outside of major transportation corridors). Additionally, the Bonneville Power Administration has transmission assets throughout the district, including a transmission substation located west of Lyons on Sub Station DR SE northwest of the intersection with Highway 226.

The Williams Gas Pipeline provides natural gas that is delivered to customers in the district by Northwest Natural Gas. These lines may be vulnerable as infrequent natural hazards, like earthquakes, could disrupt service to natural gas consumers across the region. During periods of wildfire, electric transmission lines may also be shut off by the utility to maintain public safety. The Lyons RFD has automatic backup generators for its facilities.

Water/Wastewater

The Lyons-Mehama Water District has a water storage capacity of approximately 1,850,000,000 gallons supplied by two storage reservoirs. There is additional water capacity available as needed from the Big Cliff Reservoir, which is located in Marion County approximately 3 miles downstream from Detroit Lake. However, water capacity may become constrained for the region in the event of a major disaster due to competing demands for water. Hydroelectric dams at Big Cliff Reservoir and Detroit Lake control the

flow of waters on the Santiam River, and are owned, operated, and maintained by the US Army Corps of Engineers.

During the 2020 wildfires, and the Lyons-Mehama Water District's lack of backup power resulted in pump failure and lack of water supply to the Lyons RFD which limited firefighting capacity.

Vulnerable Populations and Plans and Policies

Functional and Access Needs of Vulnerable Populations

Based on US Census American Community Survey estimates the percentage of people living in poverty in Lyons has worsened overall and also for those under 18 years old in particular. Poverty for children has significantly worsened in Lyons moving from 15% to in 2015 to 39.2% in 2022. The average age of residents of Lyons is among the highest in Linn County reflecting an aging population relative to other cities in the county. On the other hand, in 2022 median household income was among the highest in the county. For details on this information, see Appendix B: Community Profile.

Plans and Policies

The Lyons RFD engaged in the update of the Linn County Community Wildfire Protection Plan (CWPP) and is currently participating in the update of Marion County's CWPP. The District is a member of the Marion County Fire Defense Board where the District's dispatch services are located.

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the district's mitigation strategy. The county has the ability to support the small cities and districts within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the district has identified mitigations actions that will help to increase its overall mitigation capability.

Hazard Profile

The DOGAMI Multi-hazard Risk Assessment analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the following tables. The methods used for this analysis are available in the report provided as Appendix E to this plan. Table LFD-1, below, shows the hazard profile for the City of Lyons. Additional hazard profile information for the surrounding unincorporated Linn County area is summarized in Volume I, Section 2, Risk Assessment, with additional data provided in Appendix E.

Table LFD-1. Lyons Fire District Hazard Profile within City of Lyons

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Lyons	1,203	1,074	5	223,889,000

Hazus-MH Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	11	0.9%	6	0	70,000	0%
Earthquake	CSZ Mw-9.0 Deterministic	23	1.9%	126	1	12,905,823	5.8%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	20	1.7%	75	1	9,900,919	4.4%

Exposure Analysis Summary

Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	8	0.6%	6	0	1,185,000	0.5%
Channel Migration	Channel Migration Zone	22	4.7%	22	0	8,509,000	3.8%
Wildfire	High and Moderate Risk	188	16%	194	0	31,971,000	14%
Volcanic Lahar	1% Annual Chance	0	0%	0	0	0	0%

[1] Facilities with multiple buildings were consolidated into one building complex.
[2] No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).
Source: DOGAMI Multi-Hazard Risk Report, 2024

Table LFD-2. Lyons Fire District Critical facilities

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Volcanic Lahar - 1% Annual Chance
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Lyons RFD - Station 550	-	-	-	-	-	-	-
Lyons RFD - Station 570	-	-	-	-	-	-	-

Source: DOGAMI Multi-Hazard Risk Report, 2024

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and districts and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the jurisdiction representatives first updated the description, type, location, and extent of each hazard. The Lyons RFD representatives joined the process after the Steering Committee had used the Hazard Analysis Methodology exercise to rank the potential impact on the county as a whole. The results of that exercise are provided in Table LFD-3.

In this analysis, severity ratings, and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2, Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

This method can provide a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The Lyons RFD representatives refined the risk assessment with guidance from the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table LFD-4, below, represents the variation in total risk to the natural hazards as experienced by Lyons RFD representatives compared to the county level ranking completed by the Steering Committee.

Winter Storm, which was revised in 2024 to include Ice Storms, retains the top-ranking hazard for the county and the Fire District. The impact of the recent ice storm (DR-4768) on trees, power lines, and transportation routes in the Lyons RFD service area had an impact on the District in terms of an increased need for emergency response services and public information awareness campaigns. Extreme Heat and Smoke and Poor Air Quality (both newly identified hazards in this update), also rank most highly for the Fire District staff. Similarly, these events can impact response capability and increase the need for public information awareness campaigns.

Windstorm and Wildfire were identified as greater threats to the District than as ranked by the county, particularly as a firefighting and emergency response agency.

Specifically, the Fire District ranks Wildfire risk higher than Earthquake, Flood, Drought, and Flood. The maximum threat to the Lyons RFD from Wildfire caused the District representatives to rank it as a High level hazard. In addition to impacts to response capability from wildfire, the District has focused on engaging and informing District residents and visitors about fire danger levels, burn bans, and community risk reduction opportunities such as defensible space and home hardening.

Additionally, the Fire District ranks the risk of damage from Windstorms higher than the County as a whole. The frequency of Windstorms in Lyons is greater than experienced overall in the county

The District does not consider Dam Failure, Drought, Extreme Heat, Flood, Landslide, Smoke/Poor Air Quality, Volcano, Windstorm/Tornado, or Winter Storm/Ice Storm to be hazards that require mitigation action by the district and will not identify mitigation actions for those hazards. However, the district has identified multi-hazard mitigation actions that relate to public information that could help to mitigate some of these hazards.

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Table LFD-3. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table LFD-4. Relative Risks of Natural Hazards in the Lyons Rural Fire District

	Total Score	
HAZARD	**County**	**Lyons RFD**
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	same
Drought	169.0	same
Earthquake (Cascadia)	160.7	same
Wildfire	158.9	↑
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	n/a
Windstorm/Tornado	116.5	↑
Volcano	109.0	n/a
Landslide and Avalanche	106.4	same

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to the Lyons RFD. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the Lyons Fire District Hazard Profile and Critical Facilities tables (LFD-1 and LFD-2) included above, this section identifies vulnerabilities specific to the Lyons RFD, recent localized hazard events and impacts, and illustrates the basis for the Fire District's HVA scores.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018, and 2021-2023.

Vulnerability and Impacts: Drought can lead to increased probability of wildfire on forest lands, in residential areas in the Wildland Urban Interface, and in agricultural areas, in the Fire District's service area. Fire susceptibility throughout the county dramatically increases in late summer and early autumn as summer thunderstorms with lightning strikes increase and vegetation dries out.

Earthquake

Events: None.

Vulnerability and Impacts: The District's two fire stations are not identified as being vulnerable to Earthquakes. However, The Mari-Linn Elementary School, which serves students in grades K-8 and is part of the North Santiam School District, is vulnerable to a CSZ 9.0 Earthquake, as noted in the City of Lyons addenda.

Extreme Heat

Events: Excessive heat and high heat events in 2017, 2021, and 2022.

Vulnerability and Impacts: Extreme heat can lead to increased medical emergencies in the Fire District's service area.

Flood

Events: None.

Vulnerability and Impacts: The District's two fire stations are not identified as being vulnerable to Flood.

Landslide/Avalanche

Events: None.

Vulnerability and Impacts: Landslide events that impact the transportation network can hinder fire and emergency response.

Smoke/Poor Air Quality

Events: Annual field burning season periodically is exacerbated by wildfire smoke that enters the valley sometimes from outside the county.

Vulnerability and Impacts: The geography of the canyon causes air currents to funnel through the Lyons RFD. Smoke can contribute to increased medical emergencies in the Fire District's service area.

Wildfire

Events: The catastrophic 2020 Lionshead/Beachie Creek wildfire burned to the northern bank of the North Santiam River and greatly impacted the north part of Linn County, including Lyons and the surrounding areas. In addition to direct impacts from the fire, people were affected by evacuations, smoke, and road and area closures, impacting public health, recreation, and local economies.

Vulnerability and Impacts: Firefighting capacity was compromised due to electricity shutoff as the Lyons-Mehama Water District did not have back up power supply which resulted in water pumps failing to resupply firefighting equipment. As a result, the Fire District had to borrow a pumper truck from a local business. In addition, limited or undelivered notice of the evacuation order and lack of confidence that evacuation would leave property safe from vandalism and vigilante activities left residents of Lyons highly vulnerable to the wildfire and related risks.

More broadly, the Lyons RFD services areas that are classified as intermix WUI, where residents are exposed to potential fire events where there are not clear lines of demarcation between human development and wildlands. Areas of concern include the southern, western, and eastern side of the Fire District (where forestland borders development). Fire susceptibility dramatically increases in late summer and early autumn as summer thunderstorms with lightning strikes increase and vegetation dries out. The most common causes of wildfire are from humans and can include negligence in forestry operations, industrial, or agricultural activities, and recreational activities. Additionally, power, natural gas, and phone lines could be affected in the event of a wildfire. Wildfires can disrupt the intake of water on the North Santiam River and Trask Creek, either by damaging intake systems or polluting the water source, both of which could disrupt the water supply.

Winter Storm/Ice Storm

Events: Several winter storms affected the Lyons RFD since 2017, in particular the ice that accompanied the December 22, 2022, winter storm. Other events including the winter storm/ice storm in February 2021 (DR-4599) and January 2024 (DR-4768) affected the county.

Vulnerability and Impacts: The most common vulnerability to winter storms is the trees that can be impacted or brought down. This can also result in downed power lines. Other likely impact of snow and ice events on the Fire District are road closures limiting access/egress to/from some areas, especially roads to higher elevations. Winter storms with heavy wet snow or high winds and ice storms may also result in power outages from downed transmission lines and/or poles.

Windstorm/Tornado

Events: Windstorm events in 2017, 2018, 2020, 2022, and in 2023. The September 7, 2020, event resulted in rapid growth of wildfires. The December 27, 2022, event resulted in peak gusts up to 60 mph in Lyons.

Vulnerability and Impacts: Similar vulnerabilities as accompany winter storms, including downed trees and power lines.

Mitigation Strategy

During the 2023-2024 Linn County and Lyons RFD update process, the DLCD planner and Lyons RFD representatives assessed the mitigation strategy actions within the 2021 Lyons Rural Fire District NHMP. Together they revised and updated that list of actions to reflect the revised risk assessment for the district.

Table LFD-5. Actions Removed from the Lyons Rural Fire District Addendum

2021 Action Item	Hazard	Action Title	Coordinating Agencies	2021 Timeline	2024 Status	Notes
#2	Earthquake, Severe Weather, Wildfire	Assess power grid and determine methods to improve resiliency. Consider the development of a Local Energy Assurance Plan.	ODF, City of Lyons, Linn County, ODOE	Medium Term	Remove	The Fire District already has back up power supply equipment for fire stations. A broader planning effort is not within the purview of the Fire District.
#5	Earthquake	Conduct seismic strength evaluations of critical facilities and infrastructure to identify vulnerabilities and seismically retrofit (structure and non-structural) identified critical facilities and infrastructure to meet life safety standards in order to continue operations post-earthquake	Lyons RFD, City of Lyon	Long Term	Remove	The Fire District's two stations are not considered seismically vulnerable. The Fire District Main Station was assessed to have low collapse potential by DOGAMI in 2007. It is beyond the District's purview to evaluate other structures within the district that are not in its ownership.
#6	Earthquake, Landslide, Severe Weather, Wildfires	Develop and implement programs to keep trees from threatening lives, property, and public infrastructure during severe weather and other natural hazard events.	Lyons RFD, ODF, City of Lyons, Linn County, Pacific Power, Consumers Power	Ongoing	Remove	It is beyond the Fire District's purview and capacity to develop and implement programs related to tree hazards.
#7	Earthquake, Landslide, Severe	Utilize the updated regional landslide risk maps (DOGAMI O-16-02) to identify hazard areas and	Lyons RFD, ODF, City of Lyons, ODOT	Short Term	Remove	It is beyond the Fire District's purview and capacity to lead efforts

2021 Action Item	Hazard	Action Title	Coordinating Agencies	2021 Timeline	2024 Status	Notes
	Weather, Wildfires	collaborate with DOGAMI to work on landslide risk reduction efforts, particularly in areas affected by wildfire.				related to landslide risk reduction efforts.

Table LFD-6. Ongoing, Short-, and Long-Term Projects – Lyons Rural Fire District

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-hazard 1	Work with citizen groups, property owners, recreation areas, emergency responders, schools, and businesses in promoting awareness of natural hazards and what can be done to mitigate risk to life and property.	Lyons RFD, City of Lyons, ODF, OSFM, Linn County Emergency Management, OEM	Ongoing	Retain	Lyons RFD, ODF, OSFM, Linn County EM	Educating the public on how to mitigate the effects of natural hazards helps keep the public informed of what is being done, what the County is doing to mitigate risk, and what residents can do to mitigate their own risk.
Multi-hazard 2	Improve the Fire District's ability to broadcast warnings that inform and educate residents and visitors of eminent natural hazard dangers, for example purchasing updated reader boards.	Lyons RFD, ODF, City of Lyons, DOGAMI, OEM	Short Term	Retain; revised	OEM, FEMA	Improved capacity will allow more widespread dissemination of information, keeping residents and visitors informed. F
Wildfire 1	Engage in community outreach and education that prioritizes and support fuels reduction projects on private lands utilizing FireWise and other programs.	Lyons RFD, City of Lyons, ODF, OSFM	Ongoing	Retain; revised	Lyons RFD, ODF, OSFM	Revised to focus on the Fire District's role sharing information. Creating defensible space on private and public property will greatly reduce the chance of losing life and property during a wildfire.

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Wildfire 2	Implement actions identified in the Linn County Community Wildfire Protection Plan (CWPP) and continue to participate with ongoing implementation, maintenance, and update activities.	Lyons RFD, City of Lyons, ODF, Linn County EM, Marion County EM	Ongoing	Retain	Lyons RFD, ODF, OSFM, FEMA, USFS	Coordinating wildfire mitigation projects (particularly fuels reduction and defensible space) through the CWPP will help ensure collaborative efforts exist throughout the Fire District to mitigate risk.
Wildfire 3	Encourage joining the "Firewise Communities/USA" recognition program and seek to become Fire Adapted Community.	Lyons RFD, City of Lyons, ODF, USFS	Short Term	Retain	Lyons RFD, ODF	Fire adapted communities foster knowledge and engagement to mitigate the risk from wildfire. Relying on the actions of residents and agencies in relation to infrastructure, buildings, landscaping and the surrounding ecosystem they lessen the need for extensive protection actions and enable the community to safely accept fire as part of the surrounding landscape.

Plan Implementation and Maintenance

The Lyons Rural Fire District Board will be responsible for adopting the Linn County MJ-NHMP including the Lyons Rural Fire District Addendum to the Linn County Plan. The Lyons Rural Fire District Chief is responsible for coordinating implementation and maintenance of the Lyons Rural Fire District Addendum to the Linn County MJ-NHMP and will participate in the Linn County MJ-NHMP implementation and maintenance meetings. The Fire District representative will report on district specific activities as appropriate and will keep the Fire Board informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of the Fire District's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. The Lyons RFD is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, the Fire District will also review and update its addendum. The Lyons Rural Fire District Chief will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help the Fire District's Convener determine what components of the mitigation plan need updating.

CITY OF MILLERSBURG ADDENDUM

Purpose

This document serves as the City of Millersburg's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by Millersburg to improve the resilience of the community. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the information contained in Volume I (Basic Plan) of this NHMP which serves as the plan foundation and Volume III which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

Millersburg participated in the Linn County MJ-NHMP planning process for the first time during this 2023-2024 update.

During 2023 and 2024 Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities, including Millersburg, to update their addenda to the Linn County Natural Hazard Mitigation Plan, which expired May 23, 2023.

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the City of Millersburg will gain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Millersburg joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on 12/22/2022. On 11/21/2023, 2/7/2024, 3/13/2024, 4/3/2024, 7/17/2024, and 10/23/24, Millersburg's Community Development Director, Matt Straite, and City Manager, Kevin Kreitman, participated in meetings facilitated by DLCD Planner Katherine Daniel, including to conduct a risk assessment exercise with other county jurisdictions that included a Hazard Vulnerability Assessment ranking. City staff met again with DLCD on 9/12/2024 to update this addendum.

Millersburg staff promoted the NHMP survey and outreach efforts throughout the plan update, as identified below.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Millersburg Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Millersburg Addendum, are the result of a collaborative effort between residents, public agencies, non-profit organizations, the private sector, and regional organizations. Public officials, including Millersburg's Community Development Director and City Manager, guided the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary section, and Planning and Public Process (Appendix A).

The Millersburg Community Development Director is the designated convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the Addendum to the Linn County NHMP in collaboration with Linn County.

The Millersburg staff and the DLCD Project Manager wrote the Millersburg Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the process city staff and other participants provided additional information on potential funding sources, action items, and local resource and capacity constraints.

The City of Millersburg advisory group was comprised of the following individuals:

- Kevin Kreitman, City Manager
- Matt Straite, Community Development Director
- Janelle Booth, Assistant City Manager/City Engineer

Millersburg staff used multiple approaches to engage the public. The City staffed an information table at two city events, the National Night out on August 6, 2024, and the Millersburg Celebration on September 7, 2024. At these events Community Development Director Matt Straite interacted with several members of the public regarding the Hazard Mitigation Plan. There was no specific input provided on mitigation measures that should or should not be included in the plan, but there was discussion about state requirements to plan for Climate Friendly and Equitable Communities.

The advisory group was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the advisory group were provided an opportunity for comment via the plan review process (see Appendix A for more information).

The convener for Millersburg's NHMP, Matt Straite, will also remain active in the county's implementation and plan maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[24] This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards*.

[24] 44 CFR 201.6(2)(i)

Community Profile

This section provides information on city specific assets and populations. For additional information on the characteristics of Millersburg, in terms of geography, environment, population, demographics, employment and economics, and housing and transportation, see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

The City of Millersburg is located in Linn County. The city's southern boundary abuts Albany and follows the western boundary of I-5 north from approximate exit 234 at the south to just north of exit 238. The City averages approximately 4.3 miles north to south and 0.9 miles east to west, with a total area of 4.26 sq. mi. (2,729 acres). The community of Millersburg was first recognized in 1871 and was incorporated in 1974.

Temperature in Millersburg typically varies from 36°F to 86°F and is rarely below 26°F or above 97°F. Rain averages 43 inches a year, with an average of 4 inches of snow per year.

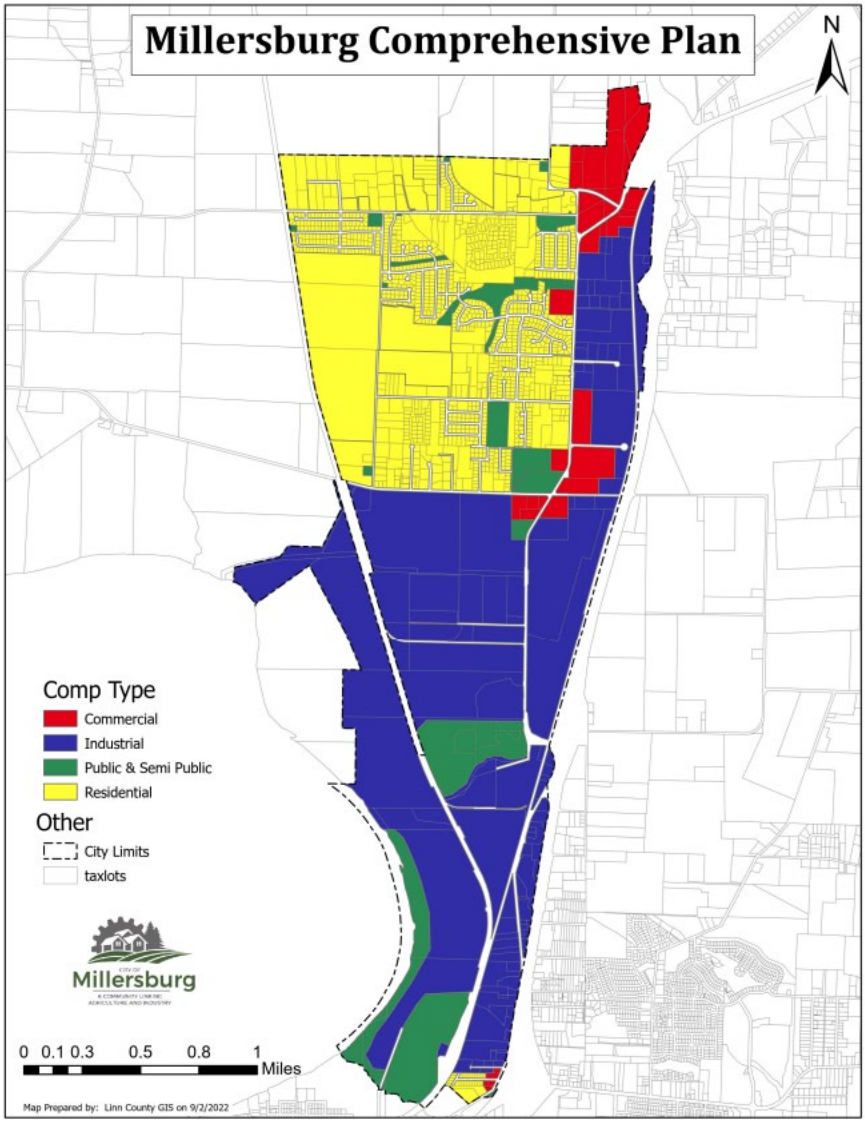
Due to its location in the Willamette Valley, Millersburg's topography is relatively flat. However, the Cascade Mountains begin approximately 20 miles to the east. Major rivers include the Willamette to the west, the South Santiam and convergence of the North Santiam to the east, and the Santiam River (post convergence of the North and South Santiam) to the north where it intersects with the Willamette River.

The Population Research Center at Portland State University lists Millersburg's 2023 population at 3,206 in April 2024, and corrected that to 3,153 in December 2024 per the City. This represents almost a doubling from 2015 when the population was 1,620. For more demographic information, refer to Appendix B.

Historically, Millersburg is an industrial, agricultural, and railroad community. Although agriculture is still an important industry in the surrounding areas, more than 50 percent of the City's assessed value is industrial with 80 percent of the labor force in Millersburg employed in industry and 20 percent in commercial.[25] Millersburg provides a large number of industrial jobs to the region, primarily to the larger nearby urban centers such as Albany/Corvallis, Salem/Keizer, and Eugene/Springfield. ATI Specialty Alloys and Components is the largest employer Millersburg and the largest industrial employer in our region. They are also an industry of national significance in providing materials critical to areas such as the aerospace industry, energy, medical devices, national defense, and space launches to name few. The median household income for Millersburg in 2023 was $119,148. For more economic information, refer to Appendix B.

[25] Oregon Employment, Quarterly Census of Employment and Wages, 2019.

Figure ML-1. Millersburg Comprehensive Plan Map



Source: City of Millersburg, 2022, approved_comp_plan_map_revised_fall_2022.pdf (millersburgoregon.gov)

Critical and Important Facilities

Millersburg's critical and important facilities include the following:

- Millersburg City Hall, 4222 NE Old Salem Rd
- Millersburg Fire Station 15, 3215 NE Transition Parkway (operated by Albany Fire Department)
- Jefferson Fire District, Millersburg Station, 4310 Woods Rd NE

Millersburg City Hall and Fire Station 15 HVAC systems are equipped with HEPA filtration and UV protection against contagions. City Hall also has partial emergency generator coverage of major systems to support functionality during extended power outages. The Fire Station 15 generator supports 100 percent operation of the station during power outages.

Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information. The DOGAMI analysis identified a communication facility.

Transportation

Interstate Highway 5 runs north and south along the eastern edge of Millersburg. Several local arterials provide access to the east and west and redundancy to the north and south as well. Old Salem Road, in addition to I-5, is the major road within Millersburg and provides north/south transportation access throughout the city. Both roads lie within the 100-year floodplain directly to the north, south, east, and west of the city center. Flood events could cause isolation from other population centers in the county such as Albany, as well as the I-5 corridor. Millersburg has limited connectivity in the southern portion of the city with NE Old Salem Road being the only north/south transportation route south of NE Conser Road. I-5 is of critical importance for north/south functionality along the City's eastern boundary; likewise, incidents on I-5 tend to overburden NE Old Salem Road which significantly impacts the movements for emergency situations. The loss of these transportation routes has the potential to block access for emergency services and police support. Smaller county roads may provide transportation redundancies for Millersburg residents to the south. Rail lines run along the eastern and western edges of the city.

Road	Owner	Notes
Interstate 5	ODOT	North/South route on the eastern edge of the city
Millersburg Drive	City of Millersburg	East/West route within the city
Conser Road	City of Millersburg	East/West route within the city
Old Salem Road	Linn County	North/South route within the city
Railroad	Union Pacific	North/South route east side of city
Railroad	Burlington Northern/Portland Western	North/South route west side of city

Energy

Millersburg receives power from Pacific Power (PacifiCorp) with two major electric substations located in the city providing power to our industrial and residential customers. Natural Gas is provided by Northwest Natural Gas via a 4-inch 400 psi pipeline generally following Old Salem Road. Millersburg is also home to Pacific Power's Willamette Operations division, which historically results in much faster responses to power outages within the city. Given our large concentration of industrial users, Millersburg residents receive the advantage of being on one of Pacific Power's most redundant and hardened systems in the state. This was enhanced by the addition of the substation on Conser Road to meet new industrial load needs. This new investment has resulted in new conductoring/reconductoring of the power system within the city, and now provides multiple pathways to supply power to our residential customer areas, which should further minimize power outages and length of those outages when they occur.

Water/Wastewater

The City has joint ownership of water and wastewater treatment systems with the City of Albany and sole ownership of the water and wastewater conveyance systems in the City.

Millersburg's water supply is received from the South Santiam River, with Millersburg primarily receiving water from the jointly owned state-of-the-art membrane treatment plant east of the city. A seismic valve was recently added to the reservoir outlet and the facility is slated for installation of new generators to ensure the capability to produce water during an extended power outage. There is an emergency tie in at the south end of Millersburg, which enables Millersburg to receive water from the City of Albany Vine Street facility if necessary.

The wastewater produced by Millersburg is conveyed by a combination of gravity piping and pumping to the Albany-Millersburg Water Reclamation Facility where it is treated and discharged to the Willamette River. The City's collection system includes four pumping stations. The two largest pump stations were upgraded with new pumps and emergency generators. A large portion of the water and sewer pipe network is newer.

Emergency Services

The City of Millersburg owns Fire Station 15, which is a state-of-the-art facility, completed in 2022 to Essential Services Standards to ensure continued operation after an earthquake or other major event. The community room was designed to function as an Emergency Operation Center for the City if required and act as the City's backup for operations if City Hall becomes non-functional. The whole facility is designed to be operated by the emergency generator. The facility's outside air intake can be immediately shut down in the event of a need to shelter in place and includes HEPA Filtration with UV air treatment to minimize the transmission of airborne contagions.

Fire and ambulance service is provided by a three-person paramedic engine company through a contract with Albany Fire Department, which also provides Millersburg full access to Albany Fire Department's resources, including EMS transport.

Jefferson Fire District's Millersburg Station does not provide initial service to the City. Response from this station within Millersburg would be addressed through a mutual aid request by Albany Fire Department.

Law Enforcement is provided through a contract with the Linn County Sheriff's Office.

Community Assets, Vulnerable Populations, and Plans and Policies

Cultural/Historical Resources

The City of Millersburg includes a Historic Overlay Zone. There are two properties that feature this overlay zone - the Miller Cemetery and the Morningstar Grange Hall.

The Miller Cemetery is on the corner of NE Woods Road and NE Millersburg Road on about 2.2 acres. The Cemetery dates to 1857 though many graves predate this. This site has no structures of any kind and is of low risk for any kind of natural disasters. Serval large trees once surrounded the site, but many of those have fallen recently.

The Morningstar Grange was built in 1901, at the cost of $85. The building is now 122 years old. The facility and the Grange organization has continued to serve not only Millersburg, but the surrounding farming community as well. The Morningstar Grange #311 is a branch of the national Grange organization. The building was added to the Zoning Overlay in 2023.

The building features two stories with a kitchen and meeting area in the basement and a meeting hall on the upper floor. It is not clear what the capacity is for the Hall.

Functional and Access Needs of Vulnerable Populations

The City of Millersburg has experienced strong population growth since 2015. It is among the fastest growing cities in the county with the greatest number of children under 18 years old per hundred people potentially within the workforce, a statistic called the Child Dependency Ratio. This ratio is higher than for the county as a whole, while the Old-Age Dependency Ratio is lower than the county's ratio of people over 65 compared to those of working age. The median income in Millersburg is more than double the median income for the county, suggesting that vulnerabilities related to age and income are limited in Millersburg. Furthermore, in Millersburg, the percentage of residents with a graduate degree or higher and those with a bachelor's degree or greater are the greatest of any city in Linn County. The city is also fortunate to have a large percentage of residents with current or past fire and emergency services, law enforcement, and healthcare backgrounds, when compared to cities of similar size.

As one of the youngest cities in Linn County (1974) the majority of Millersburg's infrastructure is newer and includes design features to protect against natural hazards. Additionally, the majority of the residential construction in the community has been built since 2010 on residential lots of 10,000 sq. ft., which meet newer building code requirements. Combined, the age and building code requirements result in a higher level of survivability for most natural hazard events. Newer construction standards and the spacing provided by our larger lot sizes greatly reduce the potential of fire spread risk often encountered with structure-to-structure fire spread in major earthquake and storm related incidents. This places the community in a much stronger hazard mitigation position than that of most communities within the County and State.

See Appendix B: Community Profile for additional demographic, economic, and built environment information.

Plans and Policies

The Millersburg Comprehensive Plan was first acknowledged by the Oregon Land Conservation and Development Commission in 1983. The City last amended the plan in 2022 wherein the Housing Chapter was revised. The City implements the plan through the Development Code of Millersburg, Oregon, which was last revised in January 2024 after being fully replaced with an all new Code in 2020.

Millersburg currently has the following plans that relate to natural hazard mitigation. The City's website makes these documents available for review online.

- Comprehensive Plan (1982, last amended December 2022)
- Development Code (revised January 2024)
    - Floodplain Overlay Zone, Chapter 2.12
- Capital Improvement Program 2024-2028
- Water System Master Plan, December 2017
- Water Management and Conservation Plan (updated 2022)
- Sanitary Sewer System Master Plan, March 2017
- Transportation System Plan, Volume I (revised Spring 2023)

- Stormwater Master Plan, January 2019
- Park System Master Plan, April 2020

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's mitigation strategy. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city has identified mitigations actions that will help to increase Millersburg's overall mitigation capability.

Hazard Profile

The DOGAMI Multi-Hazard Risk Assessment (MHRA) analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the tables below. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table ML-1. City of Millersburg Hazard Profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Millersburg		3,207	2,049		3	878,299,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	9	0.3%	5	0	61,000	0%
Earthquake	CSZ Mw-9.0 Deterministic	65	2.0%	279	2	83,644,164	9.5%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	143	4.4%	447	2	158,515,773	18%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	1	0%	3	0	291,000	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.
[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).
Source: DOGAMI Multi-Hazard Risk Report, 2024

Table ML-2. City of Millersburg Critical Facilities

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Albany Fire Department - Millersburg Station 15	-	-	-	-	-
Jefferson RFPD - Millersburg	-	X	X	-	-
Millersburg City Hall*	-	X	X	-	-

*Portion of City Hall is a more recent addition, which would not be as susceptible to earthquake damage.
Source: DOGAMI Multi-Hazard Risk Report, 2024

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the jurisdiction representatives first updated the description, type, location, and extent of each hazard. Next, they updated the Hazard Analysis Methodology based on each hazard's potential impact on the county as a whole. The results of that exercise are provided in Table ML-3.

In this analysis, severity ratings, and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2, Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

This method provides the City of Millersburg with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The City of Millersburg representatives refined the risk assessment with guidance provided by the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table ML-4, below, represents the variation in total risk to the natural hazards as experienced in the City of Millersburg compared to the county level ranking completed by the Steering Committee.

Winter Storm/Ice Storms were identified as the top-ranking hazard for the county and for the city. Extreme Heat and Smoke/Poor Air Quality (both newly identified hazards in this update) were also identified as top hazards of concern by City of Millersburg staff.

Drought threats are likely lower than the county. Flood threats in Millersburg are similar to the county.

Wildfire is a lesser threat to the city than it was ranked by the county. This is due to generally flat terrain and lack of extensive stands of trees/brush with connectivity which could support a wildfire incident within and adjacent to Millersburg.

Volcano and Dam Failure are hazards of similar level of concern as for the county as a whole. Mitigation for a Volcano would likely be related to ash fallout and air quality. Dam failure inundation mapping shows greater potential for impacts to the city involving dams on the Santiam basin watershed than failure of dams on the Willamette watershed. Both Foster and Green Peter Dams have low risks of failure based on reports from the Corp of Engineers. Given our distance from the dams, likely impacts would not exceed what would be expected in a flood situation with similar mitigation matters. The Dam Failure hazard in this plan relates to non-federal dams, as such these two federal dams will not be addressed in this plan.

Landslide and Avalanche hazards are virtually non-existent in Millersburg given its generally flat to mild sloping terrain, and as such the city will not identify mitigation actions for those hazards.

Table ML-3. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table ML-4. Relative Risks of Natural Hazards in Millersburg

	Total Score	
HAZARD	**County**	**Millersburg**
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	same
Drought	169.0	↓
Earthquake (Cascadia)	160.7	same
Wildfire	158.9	↓
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	same
Windstorm/Tornado	116.5	same
Volcano	109.0	same
Landslide and Avalanche	106.4	n/a

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Millersburg. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Millersburg Hazard Profile and Critical Facilities tables (ML-1 and ML-2) included above, this section identifies vulnerabilities specific to Millersburg, recent localized hazard events and impacts, and illustrates the basis for the city's HVA scores.

Dam Failure

Events: None

Vulnerability and Impacts: Although this is an unlikely event the potential impacts from a dam failure on Millersburg would likely be similar to impacts in a major flood scenario and addressed as such.

Drought

Events: No history since the City's incorporation or prior.

Vulnerability and Impacts: Given current history, and short of actions to remove storage capacity associated with dams within the Santiam River watershed, any risks associated with a drought should remain low.

Earthquake

Events: No past history, although we know the potential for an event remains high.

Vulnerability and Impacts: The City is a relatively young city. The majority of the infrastructure and residential structures have been constructed under newer building codes which provide for increased potential of survivability and operability post event. However, a seismic event includes the potential for major disruptions to areas outside of the community, as well as our industrial base, which provides jobs to a large regional area. Not only could the lost revenue associated with the industrial base potentially present an issue to the city, seismic impacts to the industrial base could potentially result in product releases of hazardous chemicals. State and Federal regulations regarding the safe handling and use of hazardous materials would likely reduce the potential of a large-scale release, but it should still be listed as a vulnerability. Impacts to communication systems, water, wastewater, power and natural gas utilities, and transportation systems would be expected in this event.

Per the DOGAMI analysis, the Jefferson RFPD station in Millersburg and Millersburg City Hall may be vulnerable to a CSZ 9.0 and Turner and Mill Creek Fault 6.6 earthquake, though the more recent addition to City Hall would be less susceptible. A community lifeline communications facility was also found to be vulnerable to a Turner and Mill Creek Fault earthquake.

Extreme Heat

Events: Extreme heat events have occurred throughout history and remain a possibility. However, even in extreme situations this area normally sees good recovery temperatures at night during these events.

Vulnerability and Impacts: Low, as long as it is not an extended event or involves loss of the power grid.

Flood

Events: The 1996 flood impacted industries within Millersburg (ATI and the Albany Paper Mill-now closed). ATI still maintains a water intake located on the Willamette River that could be impacted by flooding. In 1996, there were some impacts to ATI operations on site (Truax Creek to the Willamette River). Otherwise, the city saw minor impacts with flooding occurring on Old Salem Road at Truax Creek and on Millersburg Drive at Crooks Creek.

Vulnerability and Impacts: Since the 1996 flood event, culverts underneath the Union Pacific Railroad on the west side of Old Salem Road at Truax Creek were expanded from a single culvert to three culverts, and the replacement of the bridge over Truax Creek has occurred.

Modeling has shown that these improvements should prevent future issues in a 100-year flood event. Millersburg Drive has also been upgraded since that time to city street standards and a box culvert previously at Millersburg Drive on Crooks Creek was replaced with a new bridge. The new bridge and elevation of street should prevent future access issues in this area as well.

Overall, Millersburg's flood risk is greatest along the Willamette River. However, there is minimal property development in the flood zone and no development in the floodway. The northern portion of the city may be subject to minor flooding along Crooks Creek and influences of flooding along the Santiam River north of the City. The remaining areas of the city have minimal development in the floodplain.

Figure ML-2. Special Flood Hazard Area in Millersburg

Source: City of Millersburg, Linn County GIS-FEMA Layers

Smoke/Poor Air Quality

Events: Two events in the last five years. Predominantly has occurred in the August/September time frame when east winds are most likely to be prominent with fires occurring east of the valley in the Cascades resulting in smoke events.

Vulnerability and Impacts: The largest risk involves those with underlying respiratory or cardiovascular issues. Limiting outdoor activities and utilizing N95 masks can minimize impacts. Additionally, forecasting of these events usually provides enough time for vulnerable populations to prepare and/or relocate if required.

Volcano

Events: None.

Vulnerability and Impacts: Although the risk is low, during the eruption of Mount St. Helens, the Willamette Valley experienced ash fallout that impacted air quality and required additional provisions to protect the air intakes of combustion driven motors. Air quality concerns impacting the population would be addressed with smoke/poor air quality provisions addressed previously. A heavy ash fall out could require removal/disposal which would likely be handled similar to how a heavy snow fall event would be addressed. Finally, an eruption of a volcano impacting the Santiam River basins could result in mud flows impacting the region and our water treatment facilities.

Wildfire

Events: Two events in the last 5 years. Predominantly has occurred in the August/September time frame when east winds are most likely to be prominent with fires occurring east of the valley in the Cascades resulting in smoke events.

Vulnerability and Impacts: The City's geographic location, terrain, and fuel models do not support an ongoing wildfire risk scenario.

Winter Storm/Ice Storm

Events: Winter snow and ice storms are not unexpected in the Willamette Valley, however occurrences resulting in long-term impacts are rare, including notable ice storms in February 2021 (DR-4599) and January 2024 (DR-4768). The ice storm in the winter of 2021 resulted in numerous downed trees and lines throughout the community.

Vulnerability and Impacts: The majority of hazardous trees which could impact transportation access routes in the future have been addressed. Additionally, the opening of the new Pacific Power substation on Conser Road has resulted in new conductoring/reconductoring of the power grid in the City which has resulted in increased reliability. Although uncommon, larger snow accumulation events have occurred in the area with snow accumulation exceeding 6-12 inches which would require activation of snow removal on critical transportation routes, followed by local access streets.

Windstorm/Tornado

Events: Millersburg, like the rest of the Willamette Valley, is subject to disruption from high wind events. The majority of issues would be related to downed trees and power lines.

Vulnerability and Impacts: The majority of the power transmission lines in Millersburg are void of trees which could impact the lines. Most of the residential areas are serviced by underground utilities. The majority of critical infrastructure, both public and private, has back up power to address short-term risks associated with a power outage as the result of a wind event.

Mitigation Strategy

During the 2023-2024 Linn County and Millersburg update process, the DLCD planner and Millersburg representatives developed mitigation strategy actions to reduce risk from natural hazards for the city.

Table ML-5. Ongoing, Short- and Long-Term Projects – Millersburg

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Agency	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 1	Complete a Continuity of Operations Plan (COOP)	City Emergency Management	Planning, Emergency Management, Fire, Police	Short-term	New	City General Fund	
Multi-Hazard 2	Update city website to include information on natural hazards in Millersburg and provide links to resources for our residents.	City Staff	Planning, Administration	Short-term	New	City General Fund	
Multi-Hazard 3	Provide NHMP awareness training to city staff to incorporate Natural Hazard Mitigation Planning aspects into their work.	City Emergency Management	Administration, Emergency Management, Public Works	Short-term	New	City General Fund	
Multi-Hazard 4	Identify and evaluate emergency transportation routes and determine/identify roads critical to the transportation network by priority. Incorporate into COOP.	City Engineer	Public Works, Emergency Management, Linn County, ODOT	Short-term	New	City General Fund	

Hazard Action Item	Action Title	Coordinating Agency	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 5	Prepare residents to manage without power, utilities, or transportation during disaster event; communicate and promote readiness; build cooperative relationships with private businesses for assistance during disaster.	City Emergency Management	Administration, Emergency Management	Ongoing	New	City General Fund	
Multi-Hazard 6	Develop and maintain Emergency Resource List.	City Staff	Administration	Ongoing	New	City General Fund	
Multi-Hazard 7	Evaluate adding backup power to Crooks Creek and Burkhart Creek sewer pumping stations.	City Engineer	Public Works	Short-term	New	Grants - Sewer Fund	
Multi-Hazard 8	As the City of Millersburg's Strategic Plan is updated, incorporate and link Millersburg's Natural Hazard Mitigation Plan objectives into the Strategic Plan.	City Emergency Management	Fire, Public Works, Emergency Management	Short-term	New	City General Fund	
Multi-Hazard 9	Strategize with ODOT to add auxiliary lanes to I-5 and/or add planned interchange improvements to create a new on ramp/off ramp in the center of Millersburg to help north/south traffic flow and	Community Development Director	City Engineer, City Emergency Management, County Emergency Management, County Road Department, ODOT	Long-Term	New	City General Fund	

Hazard Action Item	Action Title	Coordinating Agency	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
	emergency vehicle access within Millersburg.						
Drought 1	On an as-needed basis, update Water Management Conservation Plan (WMCP).	City Engineer	Engineering/PW	Ongoing	New	Water Fund	
Earthquake 1	Complete a seismic vulnerability assessment of City Hall and Maintenance Facility.	City Engineer	Fire, Public Works, Emergency Management	Short-term	New	City General Fund	
Earthquake 2	Seek funding to update structures based on risk identified in seismic vulnerability assessment.	Community Development Director	Fire, Public Works, Emergency Management	Long-term	New	Grants	
Earthquake 3	Conduct vulnerability analysis of Millersburg's sewer and water systems to identify elements with the potential for failure and seek funding alternatives to seismically retrofit.	City Engineer	Public Works	Medium-term	New	Grants	
Flood 1	Continue processing Floodplain Development Permits consistent with FEMA requirements.	Community Development Director	Planning	Ongoing	New	City General Fund	
Windstorm 1 and	Maintain and update Snow Removal Annex in COOP Plan.	City Emergency Management	Administration, Emergency	Ongoing	New	City General Fund	

Hazard Action Item	Action Title	Coordinating Agency	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Winter Storm 1			Management, Public Works				
Windstorm 2 and Winter Storm 2	Develop pre-storm strategies for coordinated debris removal following wind and winter storms. Incorporate into COOP.	City Emergency Management	Fire, Public Works, Emergency Management	Short-term	New	City General Fund	

Plan Implementation and Maintenance

The City Council is responsible for adopting the Linn County MJ-NHMP including the City of Millersburg Addendum to the Linn County NHMP. The Community Development Director is responsible for coordinating implementation and maintenance of the City of Millersburg Addendum to the Linn County MJ-NHMP and will participate in the Linn County NHMP implementation and maintenance meetings. The City of Millersburg representative will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of the City of Millersburg's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. Millersburg is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, Millersburg will also review and update its addendum. The Millersburg Convener will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Millersburg's Convener determine what components of the mitigation plan need updating.

CITY OF SCIO ADDENDUM

Purpose

This document serves as the City of Scio's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by the City of Scio to improve the resilience of the community. Mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Please also refer to the information contained in Volume I (Basic Plan) of this NHMP which serves as this plan's foundation and Volume III which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

During 2023 and 2024 Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities, including Scio, to update their addenda to the Linn County Natural Hazard Mitigation Plan, which expired May 23, 2023.

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the City of Scio will gain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Scio joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on 2/12/2024. On 2/7/2024, 3/13/2024, 7/17/2024, and 10/23/24 Scio City Manager Ginger Allen participated in meetings facilitated by DLCD Planner Katherine Daniel including to conduct a risk assessment exercise with other county jurisdictions that included a Hazard Vulnerability Assessment ranking. City staff met again with DLCD on 9/17/2024, 11/7/2024, and 12/11/24 to update this addendum.

Scio staff promoted the NHMP survey and outreach efforts throughout the plan update. Staff hosted an information table at Scio's National Night Out Event on August 6, 2024, and conducted an informational survey and encouraged community participation through the NHMP survey handout. A link to the County NHMP update webpage was provided on the City's emergency disaster planning webpage and the city also distributed natural hazard informational materials at the Annual Lamb and Wool Festival, on the City of Scio's Facebook page, and on the service counters of Scio City Hall and Scio Library. Most of the information sharing began in the April of 2024 and continued through August 2024. Materials are still available upon request. City staff will be researching ways to make the various material available to Scio residents on a permanent basis. It is important to note

that the City is heading into a two-year city hall renovation project. Thus, communications with the Scio community are under review at the time of this update.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Scio Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Scio addendum, are the result of a collaborative effort between residents, public agencies, non-profit organizations, the private sector, and regional organizations. Public officials, including Scio's City Manager and city staff, guided the process of developing the plan. The City also sought input from the Scio School District, Scio Mutual Telephone Association (communications company), and the Scio Fire District. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary sections, and Appendix A: Planning and Public Process.

The Scio City Manager is the designated convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The Scio City Manager and the DLCD Project Manager revised the Scio Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the update process city staff and other participants provided additional information on potential funding sources, action item prioritization, and local resource and capacity restraints.

The City of Scio advisory group included the following individuals:

- Ginger Allen, City Manager
- Cathy Martin, Administrative Assistant
- Ko Knurowski, Public Works
- Scott Starkey, Public Works

Scio city staff used multiple approaches to engage the public, as described above. The advisory group was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the steering committee were provided an opportunity for comment via the plan review process (see Appendix A for more information).

The convener for Scio will also remain active in the county's implementation and plan maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[26] This section of the NHMP addendum in

[26] 44 CFR 201.6(2)(i)

conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards*.

Community Profile

This section provides information on city specific assets and populations. For additional information on the characteristics of Scio, in terms of geography, environment, population, demographics, employment and economics, and housing and transportation see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

Scio is located in the Willamette Valley in Linn County, Oregon, approximately 18 miles southeast of Salem, at the intersection of Highway 226 and Stayton/Scio Road. Scio has an elevation of 317 feet and experiences a moderate climate. In August, the average high temperature is 80°F, and the average low temperature is 52°F. Wintertime temperatures in January range from an average high of 47°F to a low of 33°F. Scio receives an average annual precipitation of 53 inches.

Thomas Creek, which originates on the slopes of Snow Peak to the east of Scio, flows through the center of Scio. The city is located mostly on flat land, and the surrounding area is predominantly farmland, with some woodland located on the slopes surrounding Franklin Butte. As a regional center, Scio has historically provided goods and services to the rural agricultural lands surrounding the city.

The Population Research Center at Portland State University lists Scio's 2023 population at 949. This represents a slight decrease from 2020 (957) and a small increase from 2015 (850). For more demographic information, refer to Appendix B.

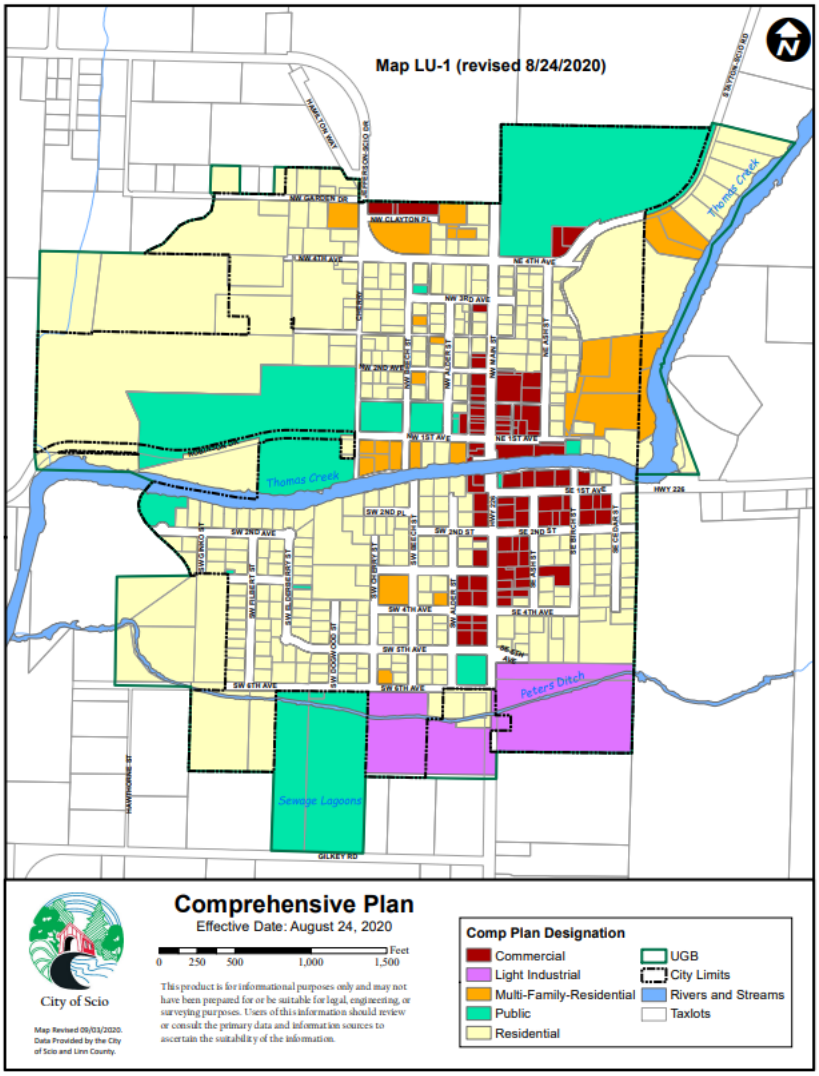
Historically, Scio's economy relied on agriculture and forestry, and the manufacturing of agriculture and forestry products. Sheep farms were an especially important resource in Scio, a fact that is reflected by the Linn County Lamb and Wool Fair, held in Scio every spring. Today, Scio's economy is centered on services, as well as transportation and communications, construction, and retail trade. Nearly 95% of all Scio jobs fall into these categories.[27]

Local farming operations remain an important part of Scio's food system, as residents depend on these farms for food and other agricultural goods. Forestry products are also still prominent in the Scio area.

Median household income in Scio in 2022 was $75,625. For more economic information, refer to Appendix B.

[27] Business Oregon – Oregon Prospector. Total Employees by Major SIC (2017) for Scio, OR. http://oregon.zoomprospector.com/

Figure SC-1. Scio Comprehensive Plan Map



Source: Scio City website, 1166 (scioregon.gov)

Critical and Important Facilities

Scio's critical and important facilities and infrastructure include the following:

- City Hall, Library and Senior Center, 38957 NW 1st Ave, Scio, OR
- Scio Rural Fire Protection District, Station 91, 38975 SW 6th Ave, Scio, OR
- Centennial Elementary School, 38875 NW 1st Ave, Scio, OR
- Scio Middle School, 38875 NW 1st Ave., Scio, OR
- Scio High School, 38880 N Main St., Scio, OR
- Scio Wastewater Treatment Facility, 38861 SW 6th Ave., Scio, OR
- Scio Public Works Shop, 38890 SW 6th Ave., Scio, OR

The following schools are located outside of Scio's city limits but are essential facilities to identify in this addendum.

- Lourdes Public Charter School, 39059 Jordan Road
- Scio Mennonite Church School, 38757 OR 226, Scio, Oregon (could be used as an emergency shelter)

Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information. The DOGAMI analysis does not identify additional community lifeline facilities in Scio.

Transportation

Main transportation corridors to and from Scio include Highway 226, which connects with Highway 20 to provide the main access to and from Albany, located to the southwest. The Stayton Scio Road provides north/south access to and from Stayton to the north, and Salem to the northwest. Highway 226 provides connectivity to I-5. Scio has one traffic bridge crossing Thomas Creek (on Main Street) and one walking bridge that could be used for traffic crossing in the case of an emergency, crossing over Thomas Creek, west of the traffic bridge located on Hwy 226. Local roads that provide transportation redundancy from the city include Jefferson Scio Drive, Robinson Road, and Gilkey Road. Several of these roads lie within the 100-year floodplain and several have some length located in the 500-year floodplain. It is possible that flood events could cause isolation from other population centers in the county such as Albany, as well as the I-5 corridor. The loss of these transportation routes has the potential to block access for emergency services and police support.

Road	Owner	Notes
OR-226	ODOT	North/South route within the city
Stayton Scio Rd		North/south route to Stayton
Jefferson Scio Dr		West through West Scio
Robinson Rd.		Alternate route west
Gilkey Rd.		Alternate route west

A bridge crossing Thomas Creek on Main Street is owned and managed both by the county and by the Oregon Department of Transportation. The City Manager provides annual reports about the bridge which serves as part of a key evacuation route. This bridge is identified as being narrower than the standard required.

The city's pedestrian bridge located near the schools can be used as egress during a natural hazard event.

Communication

Scio Mutual Telephone Association (SMTA) is a frequent participant in planning activities within the city. It is a cooperative where users own the facilities which serve Scio and the community of Crabtree. SMTA and the City of Scio have recently received a substantial grant to conduct community outreach in rural areas around Scio.

Energy

Pacific Power (PacifiCorp) is the electric utility provider in Scio. A power substation is located in the southeast area of Scio. NW Natural is the natural gas utility provider. The new Public Works shop has a generator backup power supply.

Water/Wastewater

Scio is supplied with potable water from one active well, owned and operated by the City. This artesian well is located off 4th Street and Stayton-Scio Road. A second well, located at the dead end of NW Cherry Street, serves as an emergency back up well. The City of Scio currently services 421 water connections.

The City of Scio owns and operates a wastewater treatment lagoon system, composed of two lagoon filtering ponds and a chlorine chamber. The wastewater collection system collects wastewater throughout the city and uses two lift station pump systems to transport the wastewater to the lagoons. The treatment facility and the lagoons are located at 38861 S.W. 6th Avenue, Scio, Oregon 97374.

Emergency Services

Scio Fire District provides emergency services for the city along with the Linn County Sheriff's Office. The nearest hospital is the Santiam Memorial Hospital in Stayton. Residents of Scio also rely on the Samaritan Lebanon Community Hospital located in Lebanon.

Community Assets, Vulnerable Populations, and Plans and Policies

Cultural/Historical Resources

Scio's cultural resources include five of the seven covered bridges in Linn County, located outside of city limits.

Functional and Access Needs of Vulnerable Populations

Scio is among the cities in Linn County with relatively high numbers of children as compared to the county. The ratio of children 18 or younger as compared to those aged 19-64, the group of people most likely to be in the workforce, is called the Child Dependency Ratio. The Child Dependency Ratio for Scio is 46.3, meaning that for every hundred people aged 19-64 and likely to be in the work force there are 46.3 children who depend on them. This ratio is 37.5 for Linn County overall.

Another statistic that represents vulnerable populations in Scio is the proportion of single parent households. Of the 331 households in Scio 32% contain children (18 or younger). Of those 3.3% are single parent families headed by women where there is also one or more children aged 18 or younger.

Poverty is another indicator of vulnerability. Based on the US Census American Community Survey in Scio the poverty rate for those over 65 went from 0% in 2015 to 10.7% in 2022. Other groups identified in this data including the total population in poverty, the population under 18 years old in poverty, and the population 18 to 64 in poverty decreased over this time period.

For more details on the demographics of Scio, see Appendix B: Community Profile.

Plans and Policies

The Scio Comprehensive Plan was first acknowledged by the Oregon Land Conservation and Development Commission in 1980. The city last amended the plan in 2019. The city implements the plan through the City of Scio Development Code, which was last revised in 2011.

The City of Scio currently has the following plans that relate to natural hazard mitigation, available online review or by request:

- Scio Comprehensive Plan, including Transportation System Plan (1980, last amended January 11, 2019)
- Planning Documents, include Zoning Ordinance (last amended July 2018), Land Division Ordinance (May 2006), and Flood Ordinance (September 2010)
- Water Management, Conservation, & System Master Plan (April 2015; anticipated update approval January 2025)
- Wastewater Facilities Plan (January 2020)
- Stormwater Master Plan to be conducted in the 2026-2027 fiscal year
    - 2022-2023 stormwater fee enacted to fund Master Plan
- Emergency Operations Plan under construction, anticipate completion 2026-2027.

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's strategy. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city has identified mitigations actions that will help to increase Scio's overall mitigation capability.

Hazard Profile

The DOGAMI Multi-Hazard Risk Assessment (MHRA) Report analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the following tables. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table SC-1. City of Scio Hazard Profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Scio		949	601		5**	156,690,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	210	22%	87	1	914,000	0.6%
Earthquake*	CSZ Mw-9.0 Deterministic	73	7.7%	196	0	25,128,291	16%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	163	17%	243	2	39,965,839	26%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	4	0.4%	1	0	529,000	0.3%
Wildfire	High and Moderate Risk	11	1.2%	7	0	1,996,000	1.3%

[1]Facilities with multiple buildings were consolidated into one building complex.
[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).
*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.
**Additional critical facilities included in the community risk profile for unincorporated Linn County (rural) critical facilities in the DOGAMI MHRA Report. See Table SC-2, below.
Source: DOGAMI MHRA Report, 2024

Table SC-2. City of Scio Critical Facilities

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Centennial Elementary School	-	-	X	-	-
Scio City Hall Library and Senior Center	-	-	-	-	-
Scio High School*	X	-	-	-	-
Scio Middle School*	-	-	-	-	-
Scio RFPD - Main Station	-	-	X	-	-
Scio STP**	-	-	-	-	-
Scio Public Works shops**	X	-	-	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.
**Additional critical facilities included in the community risk profile for unincorporated Linn County (rural) critical facilities in the DOGAMI MHRA Report.
Source: DOGAMI MHRA (2024)

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the jurisdiction representatives first updated the description, type, location, and extent of each hazard. Next, they updated the Hazard Analysis Methodology based on each hazard's potential impact on the county as a whole. The results of that exercise are provided in Table SC-3.

In this analysis, severity ratings, and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2 Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

This method provides the jurisdictions with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The City of Scio representatives refined the risk assessment with guidance provided by the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table SC-4, below, represents the variation in total risk to the natural hazards as experienced by the City of Scio representatives compared to the county level ranking completed by the Steering Committee.

Winter Storm, which was revised in 2024 to include Ice Storms, retains the top-ranking hazard for the county and the city. Extreme Heat and Smoke/Poor Air Quality, both newly identified hazards in this update, also rank highly for the City of Scio representatives.

Floods are of greater concern to the City of Scio than the county as a whole. Many buildings in Scio are at risk from flooding along Thomas Creek, with 85% of Scio located in the special flood hazard area.

Crustal Earthquakes put communities along Thomas Creek, including the communities of Scio and West Scio, at much greater risk than other communities in Linn County from a Turner and Mill Creek Fault Mw 6.6 earthquake.

Wildfire is of greater concern to City of Scio than it was ranked for the county.

The City does not consider Dam Failure, Landslide, or Volcano to be hazards that require mitigation action by the City and as such do not identify mitigation actions for those hazards.

Table SC-3. OEM Hazard Assessment Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table SC-4. Relative Risk of Natural Hazards in Scio

Hazard	County	Scio
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	↑
Drought	169.0	same
Earthquake (Cascadia)	160.7	same
Wildfire	158.9	↑
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	n/a
Windstorm/Tornado	116.5	same
Volcano	109.0	n/a
Landslide and Avalanche	106.4	n/a

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Scio. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Scio Hazard Profile and Critical Facilities tables (SC-1 and SC-2) included above, this section identifies vulnerabilities specific to Scio, recent localized hazard events and impacts, and illustrates the basis for the city's HVA scores.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018 and 2021-2023.

Vulnerability and Impacts: The City adopted a Water Conservation Ordinance in 2014 and routinely reviews water rates; however, water conservation measures have not had to be enacted as the city's water supply is sufficient. Drought can impact tree health throughout

the community, weakening trees' resilience to other natural hazards, such wind and winter storm, and potentially reducing canopy cover which can mitigate against extreme heat.

Earthquake (Crustal)

Events: None

Vulnerability and Impacts: Centennial Elementary School is vulnerable to a potential Turner and Mill Creek Fault 6.6 earthquake as is the Scio RFPD - Main Station, per the DOGAMI analysis. Seismic upgrades have been made at Scio Middle School and Scio High School.

Earthquake (Cascadia)

Events: None

Vulnerability and Impacts: Older building stock is a concern.

Extreme Heat

Events: Excessive heat and high heat events in 2021 and 2022.

Vulnerability and Impacts: Scio City Hall Senior Center and the Scio Fire Station Community Room are equipped to serve as cooling centers.

Flood

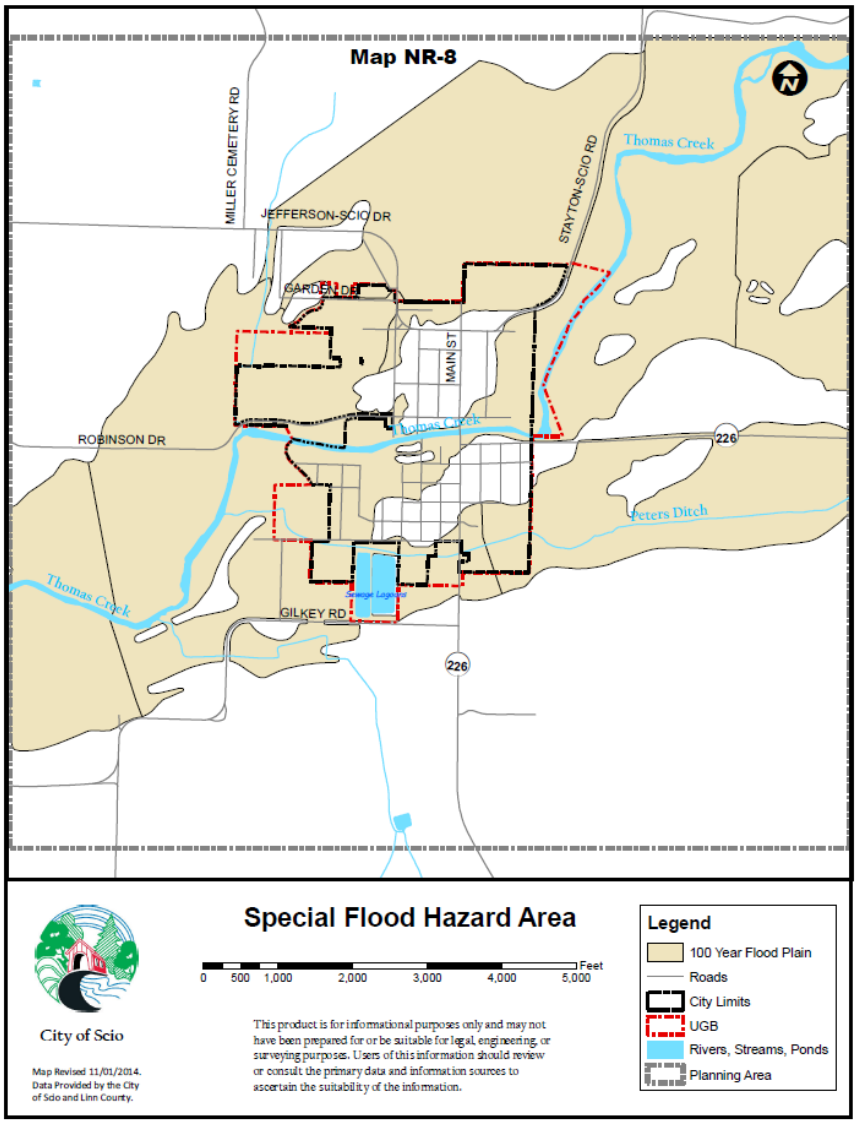
Events: Scio has a long history of floods stemming from Thomas Creek. In more recent times Scio has seen the floods of 1964, 1972, 1996, 1998, and 2012. The 1964 and 1996 floods were the largest of the events. Most flooding events occur from October to May during the rainy season, with most flooding events preceded by snow fall accumulation below 2000' elevation in the foothills east of Scio. Also, weather conditions referred to as a "Pineapple Express," warm wet weather systems originating in the South Pacific near Hawaii, dump rain on top of the snow. These rain-on-snow events result in rapid snow melt and excessive runoff following a hard ground freeze, which causes flooding of Thomas Creek and Peter's Ditch (irrigation/drainage ditch) on the south side of town.

Vulnerability and Impacts: 85% of Scio is in the special flood hazard area, as shown in Figure SC-2. The City provides online access to the Thomas Creek Water Gage so the public can look at the water level and the discharge rate of Thomas Creek at the Highway 226 crossing of Thomas Creek east of Scio. This gage is used as part of the City of Scio early flood warning system. Scio High School was found by DOGAMI to be exposed to flood hazards.

Additionally, many properties in Scio are subject to low level flooding even when the creeks do not flood. This low-level flooding can lead to standing water in people's yards which, due to the age of the homes, can lead to water intrusion. The City provides sandbags so people can protect their homes.

The Scio Mennonite Church School is located on higher ground outside of the city and can provide shelter in a flood situation.

Figure SC-2. Special Flood Hazard Area in Scio



Source: City of Scio, https://www.scioregon.gov/media/1441

Smoke/Poor Air Quality

Events: The 2020 Santiam Canyon wildfires event impacted the city with extremely poor air quality.

Vulnerability and Impacts: The city was not able to provide refuge as the smoke was so bad, however city cooling centers can provide clean air spaces for residents.

Wildfire

Events: The September 2020 wildfires were the largest wildfire event in the county.

Vulnerability and Impacts: The city was under Level 2 evacuation during the wildfires, which is predominantly a concern outside Scio city limits.

Winter Storm/Ice Storm

Events: Several winter storms and a notable ice storm in February 2021 (DR-4599) and January 2024 (DR-4768).

Vulnerability and Impacts: Winter storms can down power lines causing electricity outages.

Windstorm/Tornado

Events: In June 2023, a tornado touched down outside of the Scio city limits. No damage was reported. Strong wind events occur regularly in the Willamette Valley.

Vulnerability and Impacts: Windstorms can down trees and power lines.

Mitigation Strategy

During the 2023-2024 Linn County and Scio NHMP update process, the DLCD planner and Scio representatives assessed the mitigation strategy actions within the 2017 Scio Addendum. Together they revised and updated that list of actions to reflect the revised risk assessment for Scio.

Table SC-5. Actions removed from the Scio Addendum

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Pool #1	Multi-Hazard	Assist K-12 schools, childcare facilities and schools to develop vulnerability assessments and mitigation projects to improve safety.	Planning, Fire, Police, School District	Ongoing	Remove	Outside the City's purview
Pool #3	Multi-Hazard	Provide NHMP awareness training to City staff to incorporate Natural Hazard Mitigation Planning aspects into their daily work.	Administration, Emergency Management, Fire, Police	Ongoing	Remove	Redundant w/MH 5
Pool #5	Drought	Complete a comprehensive water rate study in the next five years as identified in the Water Management, Conservation, and System Master Plan.	Public Works, Administration	Short-Term	Remove	Included with other Drought Pool #4
Pool #6	Earthquake	Update seismic risk mapping and soil liquefaction mapping around community to direct development away from hazardous areas.	Planning, Public Works, Administration	Long-Term	Remove	Outside the City's purview
Pool #8	Earthquake	Partner with Linn County to receive seismic stability assessment information for the Main Street Bridge, as per manufacturer's recommendation, and address vulnerabilities through coordination with city emergency planning.	Public Works	Short-Term	Remove	Combined with Earthquake 3

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Pool #10	Flood	Partner with Linn County to establish a maintenance program on the drainage channel from Jefferson – Scio Drive to Robinson Drive bordering northwest Scio, and for Peter's Ditch, located in south Scio, near wastewater lagoons.	Planning, Public Works, Administration	Long-Term	Remove	County does not consider this a county issue, but a property owner issue.
Pool #11	Flood	Partner with Linn County and the Oregon Department of State Lands on downstream channel modification projects for Thomas Creek that will reduce flooding within the city limits.	Planning, Public Works, Administration	Long-Term	Remove	Highly unlikely, did not even make the state list when mentioned 7 years ago.
Pool #12	Flood	Encourage multi-objective stream and river enhancement projects that maximize flood mitigation.	Planning, Public Works, Administration	Ongoing	Remove	These large projects are out of the hands of the City of Scio.
Pool #13	Landslide	Coordinate with ODOT in addressing potential landslide issues south of Scio on Highway 226 on steep slope areas.	Public Works	Short-Term	Remove	Outside the City's purview.
Pool #14	Landslide	Publicize and use the Oregon Department of Forestry's debris flow warning systems, especially for debris – laden waterways.	Public Works, Administration	Ongoing	Remove	Outside the City's purview.

Table SC-6. Ongoing, Short- and Long-Term Projects – Scio

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 1	Update emergency operations plan.	Planning, Administration	Ongoing	Retain	Future City budget, Grants	A new leadership team to be established, 1st Mtg. 4/2025
Multi-Hazard 2	Create or update a Continuity of Operations Plan (COOP).	Administration, Linn Co. Emergency Management, Fire, Linn Co. Sheriff Office	TBD	Retain	Future City budget, Grants	Leadership Team reviews and updates current COOP, will establish timeline benchmarks.
Multi-Hazard 3	Conduct public education efforts aimed at informing citizens of the natural hazards Scio is vulnerable to and mitigation measures residents can take independently to protect new and existing property.	Administration, Linn Co. Emergency Management, Fire, Linn Co. Sheriff Office	Ongoing	Retain and revise	Future City budget, Grants	Materials and education methods underway
Multi-Hazard 4	Share information to prepare residents to manage without power, utilities, or transportation during disaster event; communicate and promote readiness; build cooperative relationships with private businesses for assistance during disaster.	Administration, Linn Co. Emergency Management and Sheriff, Scio Fire	Ongoing	Retain and revise	City budget, Scio Team Agencies Linn Co. EM, OEM, OSFM	

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 5	Provide NHMP awareness training to City staff to incorporate Natural Hazard Mitigation.	Administration	Ongoing	Retain	Future City budget, Grants	As updates occur, information sharing takes place at staff meetings.
Drought 1	Monitor the effectiveness of the Water Conservation Ordinance (adopted in 2014), and routinely review water rates.	Public Works	Ongoing	Retain and revise	City budget	Funding to be placed in 2025-2026 budget. Most recent water rate study was in 2018-2019, conduct updated study in 2025-2026 FY. Revised to included routine review of water rates.
Earthquake 1	Provide information regarding non-structural seismic retrofitting to schools, businesses, and residents to mitigate earthquake damage.	Public Works, Administration	Ongoing	Retain	Grants, BCD	Materials to be shared to be provided by BCD or otherwise prepared using grants or non-local funds.
Earthquake 2	Seek funding to Evaluate Scio's water distribution system seismically retrofit where appropriate.	Planning, Public Works	Long Term	Retain and revise	Grants, OWRD, FEMA	Revised to include need to seek funding for evaluation and retrofits
Earthquake 3	Identify funding and technical assistance to complete inventory of public and commercial buildings and prioritize structures that are vulnerable to earthquake damage.	Administration, Scio School District, Public Works, Linn Co. Emergency Management	Long Term	Retain and revise	Grants, BIZ Oregon	To be placed on Leadership meeting agenda, May/June 2025. The current structures needing earthquake seismic upgrades have already undergone upgrades. All School buildings and SMTA have earthquake upgrades. As for the other businesses that may be impacted, grants would have to be obtained.

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Flood 1	Identify funding and technical assistance to complete an inventory of locations in city of Scio subject to frequent storm water flooding outside of designated floodplains.	Administration, Public Works, Linn Co., Scio Fire, ODOT	Long Term	Retain and revise	Grants, OWEB	To be reviewed and updated. May / June 2025. No staff member is qualified to do this type of inventory. Funding and outside contractors would have to be solicited.
Flood 2	Ensure continued compliance in the National Flood Insurance Program (NFIP) through enforcement of the provisions of flood damage prevention in the Scio Municipal Code.	Administration	Ongoing	Retain	City budget	Currently working with FEMA. No funds available, just technical support from FEMA.
Flood 3	Adopt a Stormwater Master Plan.	Administration, Public Works, Linn Co., Scio Fire, ODOT	Short Term	New	City budget, stormwater fees	To be conducted in 2026-2027 FY
Wildfire 1	Implement wildfire actions in the Linn County Community Wildfire Protection Plan as they relate to Scio.	Administration, Scio Fire, Linn Co. Sheriff and Emergency Management	Ongoing	Retain	Grants, ODF, OSFM	Due to the wildfires predominantly outside Scio City limits, the City would partner with the Scio Fire District and Linn Co. EM as the leads, rendering support where possible.
Windstorm 1 and Winter Storm 1	Identify community assistance providers and review and update landscaping and tree standards to keep properties safe throughout Scio.	Administration, Public Works	Ongoing	Retain and revise	City budget, Scio Team Agencies	Completed first phase in 2021 to develop and implement standards, active and ongoing. Limited funds approved for each budget year based on identified projects.

Plan Implementation and Maintenance

The Scio City Council is responsible for adopting the Linn County MJ-NHMP including the City of Scio addendum to the Linn County NHMP. The Scio City Manager is the convener for Scio and is responsible for coordinating implementation and maintenance of the Scio Addendum to the Linn County MJ-NHMP and will participate in implementation and maintenance meetings. The Scio representative will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of Scio's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. Scio is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, Scio will also review and update its addendum. The Scio Convener will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Scio's Convener determine what components of the mitigation plan need updating.

CITY OF SODAVILLE ADDENDUM

Purpose

This document serves as the City of Sodaville's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by Sodaville to improve the resilience of the community. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the information contained in Volume I (Basic Plan) of this NHMP which serves as the plan foundation and Volume III which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

During 2023 and 2024, Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities, including Sodaville, to update their addenda to the Linn County Multi-Jurisdictional Natural Hazard Mitigation Plan, which expired May 23, 2023.

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the City of Sodaville will gain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Sodaville joined the Linn County MJ-NHMP update. On 2/7/24, 3/13/24, 4/3/24, and 7/27/24, the Sodaville City Recorder, Alex McHaddad, and subsequently City Recorder, Brandi Libra, participated in meetings facilitated by DLCD including to conduct a risk assessment exercise with other county jurisdictions that included a Hazard Vulnerability Assessment ranking. City staff Molly McGuire, Sodaville's new City Administrator/Recorder, met with DLCD on 11/25/24, 12/4/24, and 1/21/25 to update this addendum.

Sodaville staff promoted the NHMP survey and outreach efforts throughout the plan update by posting information, including a link to the County NHMP webpage, on the city's website and social media and by promoting the public input survey.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Sodaville Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Sodaville addendum, are the result of a collaborative effort between residents, public agencies, non-profit organizations, the private sector, and

regional organizations. Public officials, including Sodaville's City Administrator/Recorder and Public Works Director, guided the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary sections, and Appendix A: Planning and Public Process.

The Sodaville City Administrator/Recorder is the designated convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The Sodaville City Administrator/Recorder and the DLCD Project Manager revised the Sodaville Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the update process city staff provided additional information on potential funding sources, action item prioritization, and local resource and capacity restraints.

The City of Sodaville advisory group included the following individuals:

- Molly McGuire, City Administrator/Recorder
- J.D. Burns, Public Works Director
- Alex McHaddad, City Recorder (former)
- Brandi Libra, City Recorder (former)

Sodaville city staff used multiple approaches to engage the public, including providing information about the plan update on the city website and social media and promoting the survey in the city newsletter. The advisory group was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the steering committee were provided an opportunity for comment via the plan review process (see Appendix A for more information).

The Convener for Sodaville will also remain active in the county's implementation and plan maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[28] This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards*.

Community Profile

This section provides information on city specific assets and populations. For additional information on the characteristics of Sodaville, in terms of geography, environment, population, demographics, employment and economics, as well as housing and transportation, see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities

[28] 44 CFR 201.6(2)(i)

choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

Sodaville is located in the Willamette Valley in Linn County, Oregon, about two miles southeast of Lebanon. The city limits consist of 0.31 square miles of land. It is found in the foothills of the west Cascade Mountain Range surrounded by forested and dedicated farming areas.[29] Oak Creek runs west of the city outside the city limits. Sodaville experiences a moderate climate. The average high in August is 81°F and the average low is 51°F. The average high in January is 46°F and the average low is 33°F. Annually, the area receives an average of 44 inches of precipitation.

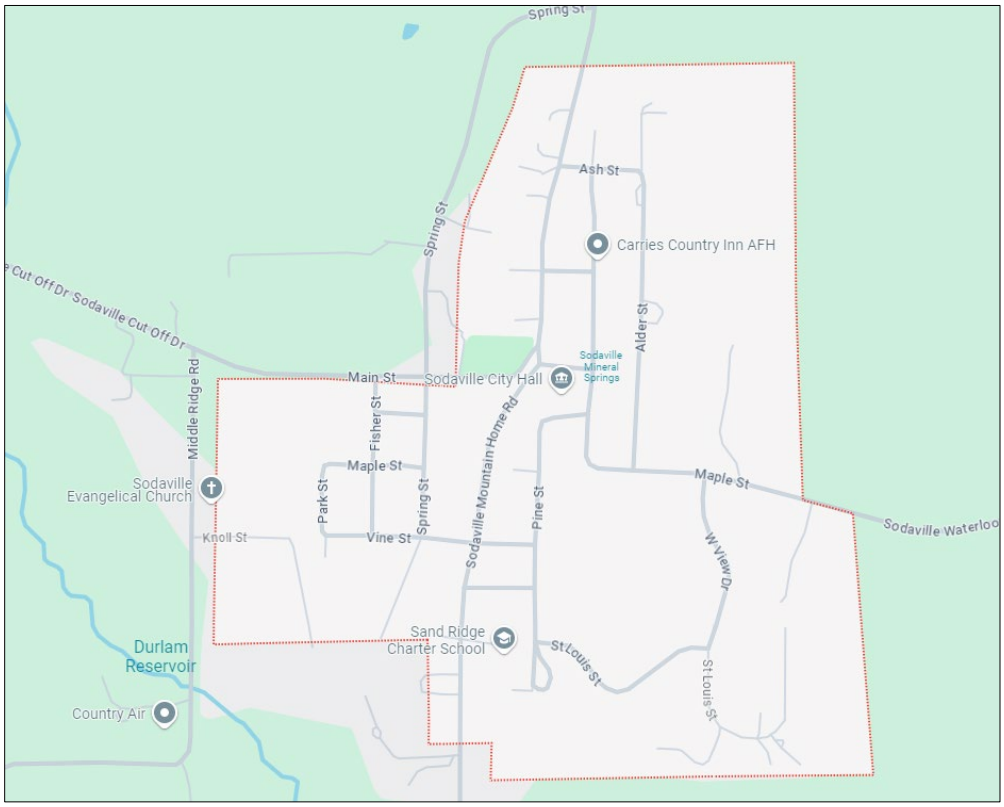
The Population Research Center at Portland State University lists Sodaville's 2023 population at 357. This represents a minimal decrease from 2020 (360) but overall growth since 2015 (325). For more demographic information, refer to Appendix B: Community Profile.

Historically, Sodaville was known for its soda springs and the town was used as a summer resort complete with a hotel, livery stable, and cottages. Present day Sodaville has become a bedroom community for Lebanon and other nearby cities. Of Sodaville's residents who are in the workforce, the vast majority work outside of Sodaville.[30] Of the few jobs located in Sodaville, most are in construction, retail trade, and services.[31]

Median household income in Sodaville in 2022 was $53,958. For more economic information, refer to Appendix B: Community Profile.

[29] City of Sodaville Comprehensive Plan 1997: Section B: Setting.
[30] US Census Bureau. Longitudinal Employer-Household Dynamics – On the Map. Inflow-Outflow Analysis for Sodaville, OR, (2014 data). https://onthemap.ces.census.gov/, accessed September 2017.
[31] Business Oregon – Oregon Prospector. Total Employees by Major SIC (2017) for Sodaville, OR. http://oregon.zoomprospector.com/

Figure SV-1. City of Sodaville Map



Critical and Important Facilities

Sodaville's critical and important facilities include the following:

- Sodaville City Hall, 30723 Sodaville Road
- Sand Ridge Charter School – Sodaville Campus, 100 Sand Ridge Court
- Sodaville Water System building, 30572 Ridge Street
- Sodaville General Store

Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information. The DOGAMI analysis identified two churches, however they were not found to be vulnerable.

Transportation

Highway 20 is the nearest highway to Sodaville and provides access to I-5 located approximately 15 minutes west. The streets that connect to Highway 20 are Sodaville Road and Sodaville-Waterloo Road. There are other local streets connecting Sodaville to other communities, which in the event of a natural hazard occurrence can provide alternate routes for residents and emergency vehicles.

Road	Owner	Notes
OR-20	ODOT	Outside the city to the east / northeast / north

Energy

Consumers Power Inc. provides electric utility services and NW Natural provides natural gas to Sodaville. The City has one backup generator that powers the Water System building.

Water/Wastewater

According to information provided by Sodaville's Public Works staff, Sodaville receives its primary water supply from two main wells, which flow to a gravity fed water treatment facility. The facility contains two steel storage reservoirs capable of holding 750,000 gallons. Due to water supply issues, Sodaville continues to purchase water from Lebanon for about five months every year from July to December. The City has been reliant on state funding to cover the cost of this expense as the City is unable to afford it at this time. Maintenance on the system has been minimal over the years and currently the City is working on correcting that.

The wastewater produced by the city is pumped to a series of three lagoons, where it is treated. In 2009, the water treatment facility pump lifts were replaced. A large portion of the water and sewer pipe network is reaching replacement age as most was established circa 1969.

Emergency Services

Sodaville receives fire and life safety services from the Lebanon Fire District.

Community Assets, Vulnerable Populations, and Plans and Policies

Cultural/Historical Resources

Mineral Springs Park/Soda Springs Park, which contains the Soda Springs and Soda Springs Marker, is a site of historic significance for the city and is listed in the Oregon Historic Sites Database. These resources were important in the founding of Sodaville and continue as an important defining aspect of the city today. The Andrew Hale House and Sodaville Evangelical Church are listed in the Oregon Historic Sites Database.

Functional and Access Needs of Vulnerable Populations

Sodaville has a population with a median age above the county average and with a lower overall age dependency ratio. Sodaville households include 9.4% of households that are headed by single parents with children under the age of 18, and 36% of households with one or more people 65 years +. For more demographic information, refer to Appendix B: Community Profile.

Median income is below the county average. Sodaville is one of four cities in the county that has a poverty rate above 14%, which is higher than it was in 2017. In Sodaville, the percentage of residents with less than a 9th grade education is also double the county average, while the percentage of residents with a high school education or equivalent is slightly above the county average. Mobile homes account for almost 15% of the housing stock in Linn County. Sodaville has second highest percentage of mobile homes, at 38%, an

increase since 2017. More than 50% of the residential structures in Sodaville were built before 1970. For more economic and housing stock information, refer to Appendix B: Community Profile.

Plans and Policies

The Sodaville Comprehensive Plan was first acknowledged by the Oregon Land Conservation and Development Commission in 1980. The city last amended the plan in 2010, including adding a section pertaining to flood plains, which concerns Statewide Planning Goal 7, *Natural Hazards*. The city implements the plan through the City of Sodaville Zoning and Development Code, which was last revised in 2023.

Sodaville currently has the following plans that relate to natural hazard mitigation. The City's website provides these documents for online review, and they are linked below:

- Comprehensive Plan (1980, last amended in 2010)
- Zoning and Development Code (last amended in 2023)
    - Flood Damage Prevention Ordinance (October 2010)
- Water Master Plan (2004) (currently applying for SIPP grant to update, available upon request)
- Emergency Response Plan (updated April 2023, available upon request)

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's mitigation strategy. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city identified mitigations actions that will help to increase Sodaville's overall mitigation capability.

Hazard Profile

The DOGAMI Multi-hazard Risk Assessment (MHRA) analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the following tables. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table SV-1. City of Sodaville Hazard Profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Sodaville		357	271		4	48,953,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	CSZ Mw-9.0 Deterministic	1	0.2%	12	0	1,421,274	2.9%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	1	0.2%	5	0	560,484	1.1%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	49	14%	34	1	5,831,000	12%
Wildfire	High and Moderate Risk	13	3.6%	15	0	2,238,000	4.6%

[1]Facilities with multiple buildings were consolidated into one building complex.
[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).
*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.
Source: DOGAMI MHRA, 2024

Table SV-2. City of Sodaville Critical Facilities

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Sand Ridge Charter School – Sodaville Campus	-	-	-	-	-
Sodaville City Hall	-	-	-	-	-
Sodaville General Store	-	-	-	X	-
Sodaville water system building	-	-	-	-	-

Source: DOGAMI MHRA, 2024

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the jurisdiction representatives first updated the description, type, location, and extent of each hazard. Next, they updated the Hazard Analysis Methodology based on each hazard's potential impact on the county as a whole. The results of that exercise are provided in Table SV-3.

In this analysis, severity ratings, and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2 Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score and probability approximately 40%.

This method provides the jurisdictions with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The City of Sodaville representatives refined the risk assessment with guidance provided by the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table SV-4, below, represents the variation in total risk to the natural hazards as experienced by the City of Sodaville representatives compared to the county level ranking completed by the Steering Committee.

Table SV-3. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table SV-4. Relative Risk of Natural Hazards in Sodaville

	Total Score	
HAZARD	**County**	**Sodaville**
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	↓
Drought	169.0	↑
Earthquake (Cascadia)	160.7	same
Wildfire	158.9	↑
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	same
Windstorm/Tornado	116.5	↑
Volcano	109.0	same
Landslide and Avalanche	106.4	↑

Winter Storm, which was revised in 2024 to include Ice Storms, retains the top-ranking hazard for the county and the city. Extreme Heat and Smoke/Poor Air Quality, both newly identified hazards in this update, rank most highly after Winter Storm for the City of Sodaville staff.

Wildfire events are of greater concern to the city of Sodaville than are Crustal Earthquake and Cascadia Earthquake events. The impact of Windstorms and Landslides on the city were ranked as a middle-tier natural hazards in Sodaville by city staff. Flood is of less concern to Sodaville city staff than the county as a whole.

Drought has become a greater concern for the City of Sodaville than it had been in the past. The county's ranking of Drought increased since the last NHMP risk assessment exercise was conducted in 2016.

Sodaville does not consider Volcano or Dam Failure to be hazards that requires mitigation action by the city and will not identify mitigation actions for those hazards.

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Sodaville. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Sodaville Hazard Profile and Critical Facilities tables (SV-1 and SV-2) included above, this section identifies vulnerabilities specific to Sodaville, recent localized hazard events and impacts, and illustrates the basis for the city's HVA scores.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018 and 2021-2023.

Vulnerability and Impacts: Sodaville goes into water restrictions from July-December every year. The City purchases water from Lebanon and hauls it to the Sodaville reservoir. The water levels in Foster Reservoir are too low for fishers to supply enough water for the City during restriction season.

Earthquake

Events: None

Vulnerability and Impacts: Older building stock is vulnerable.

Extreme Heat

Events: June and August 2021.

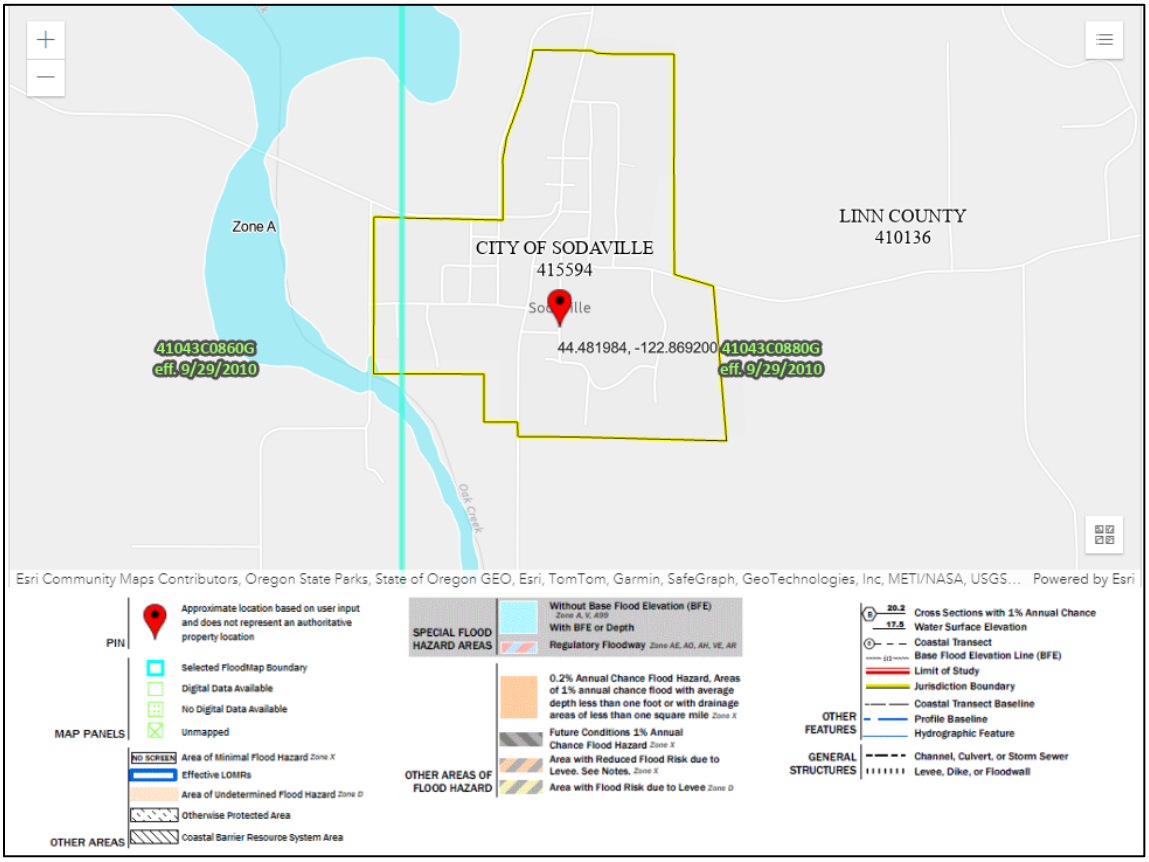
Vulnerability and Impacts: People in Sodaville in need of cooling centers were directed to Lebanon and Sweet Home during the 2021 heat dome. Both the Lebanon Library and Senior Center are equipped with air conditioning and serve as shelters for extreme heat. The heat limited ability of city crews and staff to do outside work.

Flood

Events: None.

Vulnerability and Impacts: Sodaville does not have any special flood hazard areas, as shown on the following map. As such, the city does not participate in the National Flood Insurance Program.

Figure SV-2. Special Flood Hazard Area in the Sodaville Area



Source: [FEMA Flood Map Service Center | Search By Address]

Landslide/Avalanche

Events: None.

Vulnerability and Impacts: The Sodaville General Store, an historic building owned by the City, is in an area susceptible to landslide hazards. The building needs renovation and is currently used as a storage facility. Areas outside of Sodaville in the vicinity of where Highway 20 intersects Route 228 are highly susceptible to landslide hazard.

Smoke/Poor Air Quality

Events: September 2020 wildfires caused smoke in the Willamette Valley.

Vulnerability and Impacts: The smoke limited ability of city employees to do their jobs including driving around the city.

Wildfire

Events: The September 2020 wildfires were the largest wildfire event in the county. Additionally, in August 2023, the Sodaville Cutoff Fire was ignited by farm equipment

harvesting a grass field northwest of Sodaville, prompting an evacuation order due to the fire's rapid movement and proximity to homes.[32]

Vulnerability and Impacts: Sodaville was affected indirectly by smoke and visibility issues in 2020 and area evacuation in 2023. Sodaville is surrounded by forested areas to the east, south, and southwest, and has been impacted by wildfires historically.

Winter Storm/Ice Storm

Events: Several winter storms and a notable ice storm in February 2021 (DR-4599) and January 2024 (DR-4768).

Vulnerability and Impacts: Trees and powerlines are impacted by winter storms and ice. In 2024, Sodaville lost power and some people's ability to drive was impacted due to the steepness of some roads.

Windstorm/Tornado

Events: Strong wind events occur nearly annually in the Southern Willamette Valley.

Vulnerability and Impacts: Wind microbursts are a concern during the winter in Sodaville, impacting trees and powerlines.

[32] https://www.statesmanjournal.com/story/news/local/2023/08/01/wildfire-evacuation-level-3-lebanon-linn-county-oregon-grass-fire/70509525007/, accessed 1/21/2025.

Mitigation Strategy

During the 2023-2024 Linn County and Sodaville NHMP update process, the DLCD planner and City of Sodaville representatives assessed the mitigation strategy actions within the 2017 Sodaville Addendum. Together they revised and updated that list of actions to reflect the revised risk assessment for Sodaville.

Table SV-5. Completed Actions - Sodaville

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
#3	Drought	Identify incentive programs to install water efficient devices in existing and new city owned facilities.	Planning, Administration	Short Term	Complete	New restroom, new faucets, etc.

Table SV-6. Actions Removed from the Sodaville Addendum

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Priority #8	Flood	Update applicable City codes and ordinances to improve risk reduction and prevention of flood impacts	Public Works, Planning	Short Term	Remove	City limit is not in 100-year flood plain
Priority #9	Flood	For locations with repetitive flooding and significant damages or road closures, determine and implement mitigation measures such as upsizing culverts or storm water drainage ditches.	Public Works, Planning	Long Term	Remove	City limit is not in 100-year flood plain
Priority #10	Flood	Ensure flood damage prevention through enforcement of the provisions of the flood damage prevention ordinance.	Planning, Public Works, Administration	Ongoing	Remove	City limit is not in 100-year flood plain, however the city flood damage prevention ordinance remains in effect.

2017 Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
#5	Flood	Complete an inventory of locations in city of Sodaville subject to frequent storm water flooding outside of designated floodplains	Planning, Public Work	Ongoing	Remove	City limit is not in 100-year flood plain
#6	Multi-Hazard	Assist K-12 schools, childcare facilities and schools to develop vulnerability assessments and mitigation projects to improve safety.	Planning, Fire, Police, School District	Ongoing	Remove	This is outside the City's purview

Table SV-7. Ongoing, Short- and Long-term Projects – Sodaville

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 1	Update Comprehensive Plan to reflect updated information regarding natural hazards.	Planning, Administration	Long term	Retain	DLCD Technical Assistance Grant	
Multi-Hazard 2	Create or update a Continuity of Operations Plan (COOP).	Planning, Emergency Management, Fire, Police	Long term	Retain	City budget	City has an Emergency Action Plan
Multi-Hazard 3	Provide NHMP awareness training to City staff to incorporate Natural Hazard Mitigation Planning aspects into their daily work.	Planning, Emergency Management, Fire, Police, Brownsville	Ongoing	Retain	City budget	IGA with City of Brownsville
Multi-Hazard 4	Develop public education efforts about the natural hazards Sodaville is vulnerable to and mitigation measures residents can implement.	Planning, Administration	Ongoing	Retain	City budget	Monthly Newsletters

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 5	Prepare residents to manage without power, utilities, or transportation during disaster event; communicate and promote readiness; build cooperative relationships with private businesses for assistance during disaster.	Fire, Police, Emergency Management, Planning	Ongoing	Retain	City budget	Additional funding, resources, and education materials would be helpful
Drought 1	Support local agency programs that promote measures to reduce water use during drought emergencies.	Emergency Management, Planning, Administration	Ongoing	Retain	City budget	Monthly Newsletters
Drought 2	Implement conservation measures included in the 2004 Water Master Plan (WMP).	Public Works, Administration, Planning	Ongoing	Retain	OR Assoc. of Water Utilities, Biz Oregon	
Drought 3	Adopt a Water Management Conservation Plan (WMCP).	Planning, Public Works, Administration	Ongoing	Retain	City budget	Working now to update WMCP
Earthquake 1	Inventory critical infrastructure or facilities vulnerable to seismic risk and consider options for seismic retrofit.	Planning, Public Works, Emergency Management	Ongoing	Retain	City budget	
Earthquake 2	Evaluate Sodaville's water distribution system and seek funding alternatives to seismically retrofit where appropriate.	Planning, Public Works	Long term	Retain	OWRD & Biz Oregon	
Wildfire 1	Partner with OSU Extension Service and Consumer Power on fuel reduction projects in fire-prone areas.	Fire, Parks and Recreation, Linn County	Long term	Retain	OSFM, Community Wildfire Defense Grant, ODF	

Hazard Action Item	Action Title	Coordinating Agencies	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Winter Storm, Windstorm	Coordinate with the local utility to identify any power lines that could be placed underground to prevent power outages from wind and winter storms.	Planning, Public Works	Long term	Retain	City budget	Working with Consumer Power, on 'waiting list'

Plan Implementation and Maintenance

The City Council is responsible for adopting the Linn County MJ-NHMP including the City of Sodaville addendum. The City Recorder/Administrator is responsible for coordinating implementation and maintenance of the City of Sodaville Addendum to the Linn County MJ-NHMP and will participate in the Linn County NHMP implementation and maintenance meetings. The Sodaville representative will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of the City of Sodaville's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. Sodaville is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, the City of Sodaville will also review and update its addendum. The Sodaville Convener will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Sodaville's Convener determine what components of the mitigation plan need updating.

CITY OF SWEET HOME ADDENDUM

Purpose

This document serves as the City of Sweet Home's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by the City of Sweet Home to improve the resilience of the community. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the information contained in Volume I (Basic Plan) of this MJ-NHMP, which serves as the plan foundation, and Volume III, which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

The City of Sweet Home is incorporating its current effective NHMP into this 2025 update of the Linn County Multi-Jurisdictional Natural Hazard Mitigation Plan.

During 2023 and 2024 Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities, including Sweet Home, to develop their addenda to the Linn County Natural Hazard Mitigation Plan. The current Sweet Home NHMP is effective until May 5, 2027, and will remain in effect until the City of Sweet Home City Council adopts the updated Linn County MJ-NHMP.

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the City of Sweet Home will retain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, the Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Sweet Home joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on 8/29/2024. On 10/23/2024, Sweet Home Police Chief/City Manager Pro Tem, Jason Ogden and the Assistant City Manager Pro Tem, Cecily Pretty participated in the Steering Committee meeting facilitated by DLCD to conduct a risk assessment exercise with all jurisdictions and districts joining the plan. City staff also met with DLCD Planners on 10/10/2024, 10/29/2024, and 11/13/2024 to update this addendum, including discussion of the risk assessment and Hazard Vulnerability Assessment rankings and mitigation strategy review.

Sweet Home staff promoted the NHMP survey and outreach efforts throughout the plan update by promoting the survey through city channels and posting links to the county website.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Sweet Home Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Sweet Home addendum, are the result of a collaborative effort between residents, public agencies, non-profit organizations, the private sector, and regional organizations. Public officials, including Sweet Home's City Manager Pro Tem and Assistant City Manager Pro Tem, guided the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements, Plan Summary, and Appendix A: Planning and Public Process.

The City Manager or their designee is the designated convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The City Manager and the DLCD Project Manager revised the Sweet Home Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the update process city staff engaged the executive team including public works, public information, and facilities managers. During the update process city staff and other participants provided additional information on potential funding sources and action item prioritization, reflecting local resource and capacity restraints.

The City of Sweet Home advisory group included the following individuals:

- Police Chief/City Manager Pro Tem, Jason Ogden
- Assistant City Manager Pro Tem, Cecily Pretty

Sweet Home city staff used multiple approaches to engage the public. The Sweet Home city staff posted the link to the Linn County Natural Hazard Survey to learn what priorities the residents of Sweet Home find most important. They also provided information to the public about the countywide process by posting links to the county's website for further information. The advisory group was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the steering committee were provided an opportunity for comment via the plan review process (see Appendix A for more information).

The convener for Sweet Home will also remain active in the county's implementation and plan maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[33] This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards*.

[33] 44 CFR 201.6(2)(i)

Community Profile

This section provides information on city-specific assets and populations. For additional information on the characteristics of Sweet Home, in terms of geography, environment, population, demographics, employment and economics, as well as housing and transportation, see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city-specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

Community Characteristics

Sweet Home is located in Linn County, Oregon on the south side of the South Santiam River, at the southeastern edge of the Willamette Valley in the foothills of the Cascade Mountain range. Sweet Home lies at elevations between 500 and 600 feet above sea level, with higher elevations in the hills at its southern edge. In addition to the South Santiam River, there are several creeks running through Sweet Home, including Ames Creek, Taylor Creek, Wiley Creek, and several smaller creeks.

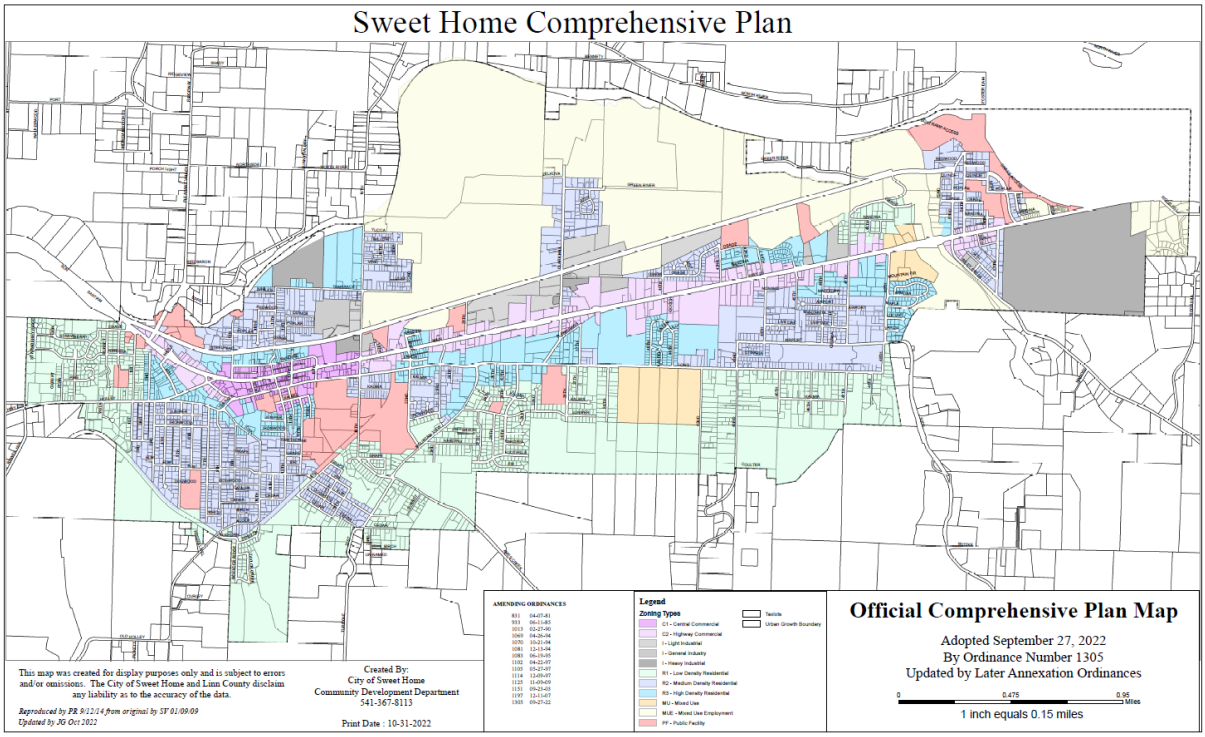
According to the United States Census Bureau, the city has a total area of 5.75 square miles, of which 5.30 square miles is land and 0.45 square miles is water. The intersection of Oregon Route 228 and U.S. Route 20 occurs at the western end of Sweet Home. Sweet Home is built on a prehistoric petrified forest. In addition to fossil wood, the area includes a variety of agate, jasper, crystals, and minerals.[34]

Sweet Home receives 51 inches of rain, on average, per year, and averages 2 inches of snow per year. Summer high temperature is around 82°F in July or August, with winter low temperature at 34°F in January.

The Population Research Center at Portland State University lists Sweet Home's 2023 population at 10,028. This represents an increase from 2015 when the population was 9,090. Annualized change between 2015 and 2023 was 1.47%, close to the growth for Linn County. The median household income in Sweet Home in 2022 was $56,783. This amount is lower than the average state median household income for Oregon. For more demographic and economic information, refer to Appendix B: Community Profile.

[34] Wikipedia, Sweet Home, Oregon, Sweet Home, Oregon - Wikipedia, accessed 10/25/24

Figure SH-1. Sweet Home Comprehensive Plan Map



Source: City of Sweet Home

Critical and Important Facilities

Table SH-1. Critical and Important Facilities in Sweet Home

Facility	Address	Back-up Generator?	Notes from 2022 NHMP
Police Dept	1950 Main St	yes	Primary ECC/Personnel & Equipment
Fire District Station 21	1099 Long St	yes	Alternate ECC/Personnel & Equipment
Fire District Station 22	1390 47th Ave	yes	Equipment
City Hall	3225 Main St	purchasing in 2025 with federally funded grant	
Sweet Home High School	1641 Long St	no	
Sweet Home Junior High School	880 22nd Ave	no*	Potential location for Emergency Operations Center
Oak Heights Elementary School	605 Elm St	no*	
Hawthorne Elementary School	3205 Long St	no*	
Foster Elementary School	5526 Poplar St	no*	
Willamette National Forest – Sweet Home Ranger District	4431 Main St	don't know	

Facility	Address	Back-up Generator?	Notes from 2022 NHMP
Additional important facilities and infrastructure identified by the city include the following:			
Public Works	1400 24th Ave	yes	Personnel & Equipment
Water Treatment Plant	1500 47th Ave	purchasing in 2025 with federally funded grant	
Wastewater Treatment Plant	1357 Pleasant Valley Rd	yes	
Long St Bridge	Long St at Ames Creek	NA	city owned, box culvert
Strawberry Water Pump Station	525 Strawberry Lp	no	
Strawberry Reservoir	700 Nandina St	no	
10th Ave Water Reservoirs	by 184 21st Ave	no	
49th Ave Water Reservoir	1185 48th Ave	no	
Lake Pointe Water Pump Station	1200 Riggs Hill Rd	yes	
Public Library	1101 13th Ave	no	
Fuel Stations	4 retail & 3 private	no	3-day supply + what is on hand
ODOT Maintenance Station	205 Main St	don't know	ODOT owned
Ames Creek Culvert	9th Ave & Main St	NA	ODOT owned
Wiley Creek Bridge	Main St at Wiley Creek	NA	ODOT owned/ Highway 20
Army Corps of Engineers Office (USACE)	3001 53rd Ave	yes	owned by USACE
Foster Dam	60th Ave	yes	owned by USACE
Foster Dam Water Intake Screen		NA	owned by USACE
Pacific Power Substation	1700 18th Ave	don't know	
Pacific Power Substation	5401 54th Ave	don't know	
Pleasant Valley Bridge	Pleasant Valley Rd at S Santiam River	NA	county owned
Sweet Home School District Administration Building	1920 Long St	no*	
Sweet Home School District Transportation	873 18th Ave	no*	
Linn-Benton Community College - Sweet Home Center	1661 Long St	don't know	
Sweet Home Community Center	880 18th Ave	no	
Sweet Home Family Medicine	679 Main St	don't know	
Linn County Health Clinic - Sweet Home	799 Long St	don't know	

* The Sweet Home School District has one tractor mounted back-up generator and several smaller generators that can be taken to schools as needed. These are stored at 1920 Long St. in the facilities dept.

The following school is located outside of Sweet Home's city limits, but still provides critical services to residents:

- Holley Elementary School, 30446 Crawfordsville Drive, Sweet Home, OR

Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information. The DOGAMI analysis identified elder care and financial institutions.

Dams and Levees

Dam failures can occur rapidly and with little warning. Fortunately, most failures result in minor damage and pose little or no risk to life safety.[35] However, the potential for severe damage still exists and should be considered in mitigation planning efforts.

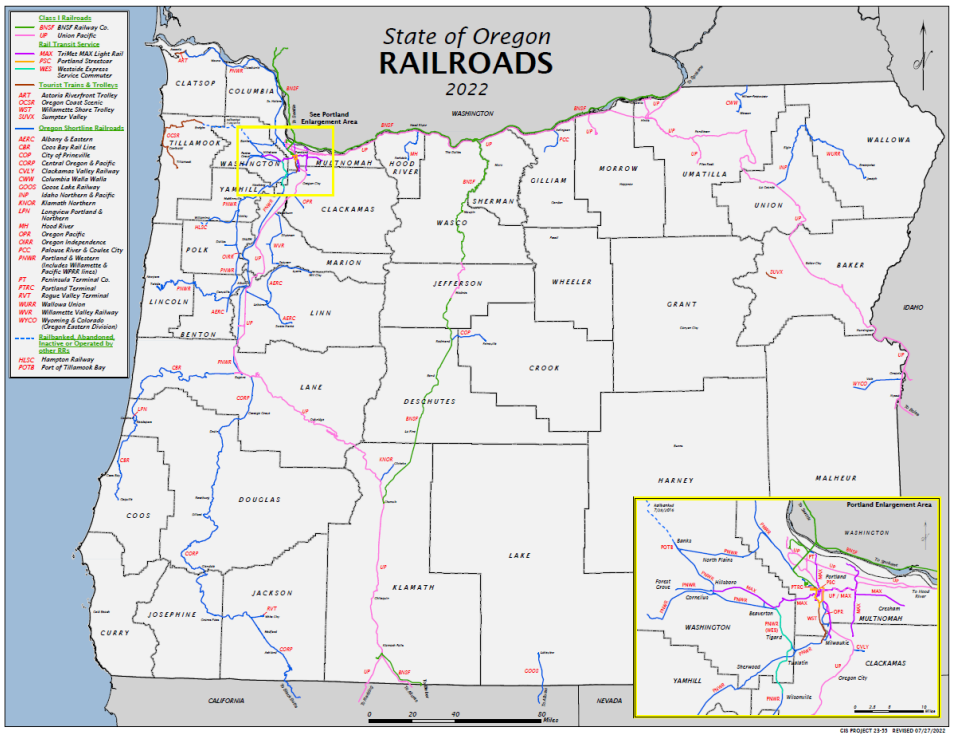
There are two large dams and reservoirs on the South Santiam River upstream from Sweet Home, the Foster and Green Peter Dams. As described in Section 2 of Volume I: Basic Plan, the dams are owned and operated by the U.S. Army Corps of Engineers. One state regulated High Hazard Potential Dam is also located in the Sweet Home city limits. The Foster Log Pond Dam is an earthen dam constructed in 1946. It is 17 ft. high and stores 375-acre feet of water. It is privately owned by Murphy Company Foster Veneer. It is inspected by the State of Oregon on an annual basis. The most recently reported inspection available on the National Inventory of Dams was conducted in September 2020 and indicated the condition of the dam was fair. No inundation map was available for this dam in the NID.[36]

Transportation

Railroads are major providers of regional and national cargo trade flows. The *State of Oregon, Oregon Railroads 2021* map in Figure SH-2 shows the Oregon Shortline Railroads that run through Sweet Home. Rail lines are sensitive to icing during winter storms. For industries in the region that use rail transport, disruptions in service can result in economic losses. The potential for rail accidents caused by natural hazards can also have serious implications for the local communities, especially if hazardous materials are involved. Sparks from rails have also been known to start wildfires.

[35] Federal Emergency Management Agency, *Dam Failure Information*, https://www.fema.gov/dam-failure-information, accessed March 12, 2019.
[36] National Inventory of Dams

Figure SH-2. State of Oregon Railroads 2022



Source: Oregon Department of Transportation, https://www.oregon.gov/odot/data/documents/Railroads.pdf

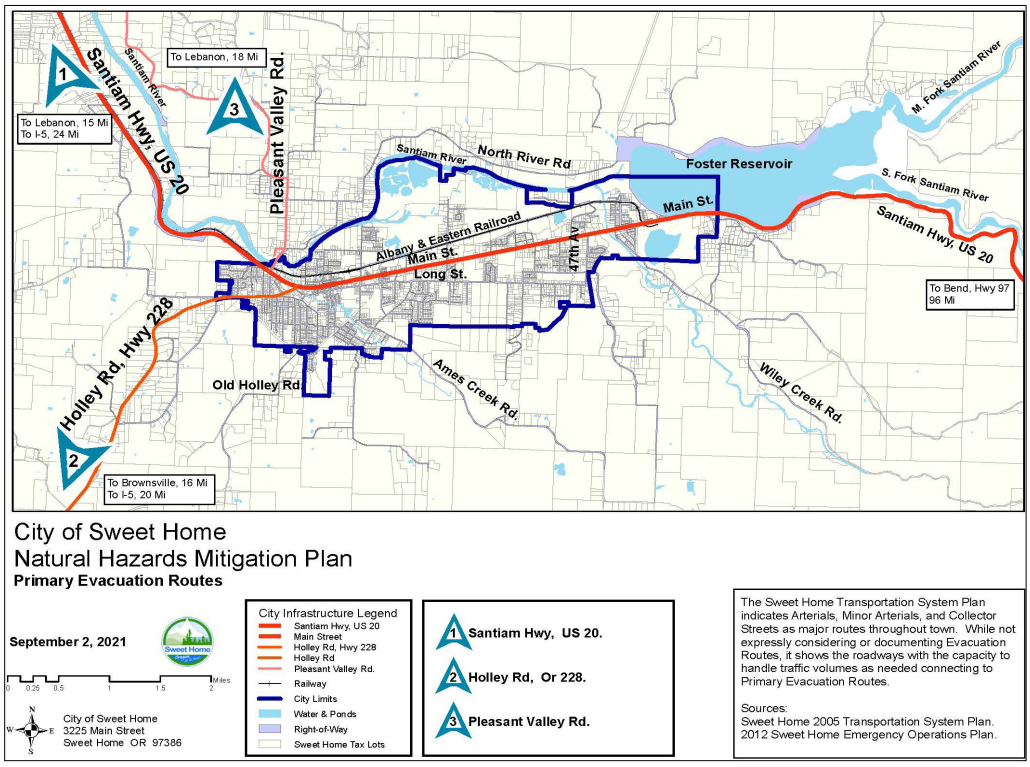
The major routes in and out of Sweet Home are identified as the Primary Evacuation Routes on the Sweet Home Evacuation Map; see Figure SH-3. Daily transportation infrastructure capacity can be stressed by maintenance, congestion, and oversized loads. Peak loads and congestion can materialize during major construction projects but can also fluctuate by season. Natural hazards tend to further disrupt automobile traffic and create gridlock; this is of specific concern in periods of evacuation during an emergency.

The existing condition of bridges in the region is also a factor that affects risk from natural hazards. Bridge failure can have immediate and long-term implications in the response and recovery of a community. Incapacitated bridges can disrupt traffic and exacerbate economic losses due to the inability to transport products and services in and out of the area.

Oregon Department of Transportation (ODOT) provides an interactive mapping program, TransGIS, which provides updated information on structures (such as bridges), highways, traffic data, and more. Bridge information is available for ODOT managed bridges, such as locations and their status (structurally deficient, closures, etc.).[37]

[37] ODOT, *2023 Bridge Condition Report and Tunnel Data*, Oregon Department of Transportation: Bridge Condition Report : Bridge : State of Oregon

Figure SH-3. Sweet Home Evacuation Map



Source: City of Sweet Home Natural Hazards Mitigation Plan, 2021

Sweet Home Langmack Airport was a private airport located two miles east of Sweet Home. The airport was founded by pilot Dr. Robert Langmack, who founded the town's hospital in the 1940s. The airport is closed, and the former location of the airport is now being redeveloped for housing. The nearest airport to Sweet Home is the Corvallis Municipal Airport.

Energy

Power sources in Sweet Home include electricity, natural gas, and solar. Backup generators are noted in conjunction with the critical and important facilities listed above.

Water/Wastewater

The City of Sweet Home provides sewer and water services to business and residences. According to the City's website, the City operates and maintains a water treatment facility and distribution system that meets strict governmental requirements while providing safe drinking water and protecting the health of the environment. Several activities are associated with the production of potable water. Production averages approximately 1 million gallons per day with peak days in excess of 2.5 million gallons.[38]

The City operates and maintains a wastewater treatment facility and appropriate collections systems in such a way as to meet strict governmental requirements for wastewater

[38] City of Sweet Home, Utility Billing, Utility Billing | Sweet Home Oregon, accessed 01/17/25

collections and reclamation, while protecting the health of the environment. This facility consists of six unit processes, including influent pumping, aeration, clarification, sludge dewatering and disposal, disinfections, and two gravity filters that are operated during certain periods throughout the year.[39] Laboratory facilities which support the operations and comply with state and federal mandates are also associated with the overall operation and maintenance, cleaning of grounds and facilities, sludge dewatering and disposal activities, process operation, monitoring and reporting.

The monitoring activities are composed of effluent flow monitoring and lab testing. The City maintains a water quality lab for the purpose of meeting state and federal regulations for treatment and discharge of municipal sewage. In-house analysis includes daily, weekly, and monthly testing for Biological Oxygen Demand (BOD), fecal coliforms, suspended solids, volatile solids, and total solids, as well as chlorine concentration and pH. Certified private laboratories perform annual and periodic testing for inorganic toxic chemicals (heavy metals), organic toxic chemicals (pesticides) and radioactive contamination. All data from these monitoring activities are collected, correlated, and entered into appropriate report formats for submittal to the regulatory agencies (DEQ and EPA).

Other objectives are to try to meet discharge permit requirements within feasible limits set forth under the City's National Pollutant Discharge Elimination System (NPDES) Discharge Permit; continue operations with effluent recycling and sludge watering improvements; and continue replacement reserve.

Emergency Services

The Sweet Home Fire District serves about 19,000 people within 152 square miles. Its Ambulance Service Area covers approximately 1,000 square miles of a very diverse geographical and demographical region. In 2022, a seismic upgrade retrofit began on the main station at 1099 Long Street to ensure that in the event a major earthquake hit, the station would remain functional.

Community Assets, Vulnerable Populations, and Plans and Policies

Cultural/Historical Resources

Sweet Home hosts the Oregon Jamboree music festival every August. Visitors to events such as the festival may be more vulnerable to natural hazards if they are not familiar with Sweet Home. While there are no listed historic resources in Sweet Home, the Weddle Bridge and East Linn Museum are considered valuable cultural resources.

Functional and Access Needs of Vulnerable Populations

Median age in Sweet Home is slightly higher than the county average, with a slightly lower Child Dependency Ratio, the ratio of children 18 or younger as compared to those aged 19-64, the group of people most likely to be in the workforce. The Child Dependency Ratio for Sweet Home is 34.5, meaning that for every hundred people aged 19-64 and likely to be in the work force, there are 34.5 children who depend on them. This ratio is 37.5 for Linn County overall. Another statistic that represents vulnerable populations in Sweet Home is

[39] City of Sweet Home, Utility Billing, Utility Billing | Sweet Home Oregon, accessed 01/17/25

the proportion of single parent households. Of the 3,922 households in Sweet Home, 32.5% contain children (18 or younger). Of those 8.8% are single parent families with one or more children aged 18 or younger.

Poverty is another indicator of vulnerability. Based on the US Census American Community Survey in Sweet Home, the poverty rate for those over 65 in Sweet Home doubled the between 2015 and 2022 to 17.4%. Other groups identified in this data including the total population in poverty, the population under 18 years old in poverty, and the population 18 to 64 in poverty decreased over this time period.

Within the built environment 15.5% of the housing stock is mobile homes, slightly higher than Linn County at 14.8%. Regarding building stock age, 30.9% of residential structures in Sweet Home were constructed since 1990 per the US Census American Community Survey; however, Sweet Home staff estimate that approximately 57% of the housing stock was constructed post-1990. The county average is 37.9%.

See Appendix B: Community Profile of this MJ-NHMP for additional demographic, economic, and built environment information.

Residents and employees of the following institutions or residential communities are or serve some of the most vulnerable people in Sweet Home:

- Wiley Creek Community
- Sapphire at Sweet Home
- Sunshine Industries

Plans and Policies

Implementing the natural hazards mitigation plan's actions through existing plans and policies increases their likelihood of being supported and getting updated and maximizes the City's resources.

The Sweet Home Comprehensive Plan was first acknowledged by the Oregon Land Conservation and Development Commission in 1982. The City last amended the plan in 2010. The city implements the plan through the City of Sweet Home Development Code, which was last revised in 2023.

Sweet Home currently has the following plans that relate to natural hazard mitigation and community development. The City makes these documents available for online review or they can be obtained by contacting the Community and Economic Development Manager.

Table SH-2. Existing Plans for Sweet Home

Jurisdiction	Document	Year
Sweet Home and Sweet Home Fire District	Emergency Operations Plan	Pandemic Response added in 2020 to January 2013 plan
Sweet Home	Development Code (Chapter 15.12 Flood Hazard Area Regulations and Title 17 Zoning of the Sweet Home Municipal Code)	Updated 2023
Sweet Home	Comprehensive Plan	August 27, 2010

Jurisdiction	Document	Year
Sweet Home	Sweet Home Transportation System Plan	May 2005, update anticipated in 2025
Sweet Home	Emergency Action Site Specific Plan, Sweet Home, OR	October 2017
Sweet Home	Emergency Response Plan: Sweet Home Wastewater and Water Treatment Plants	November 2014
Sweet Home	Sweet Home City Council Vision Statement, Mission Statement, and Goals Resolution	March 2024
Sweet Home	2021 Sweet Home Streetscape Plan	Draft 2021
Sweet Home and Linn County	Community Development Block Grant #H19012 Linn County Housing Rehabilitation Partnership Program	April 2020
Sweet Home	Sweet Home Fair Housing Resolution	2014
Sweet Home	Sweet Home Capital Improvement Plan	2024
Sweet Home	Sweet Home Park System Plan	October 2024
Sweet Home	Sweet Home Downtown Retail Market Analysis	2010
Sweet Home	Sweet Home Livability Assessment	2014
Sweet Home	Sweet Home Housing Needs Analysis	December 2022
Sweet Home	2003 Oregon Downtown Development Association Report	2003
Sweet Home	1994 Sweet Home Downtown Redevelopment Assessment Report	1994

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's mitigation strategy. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city identified mitigations actions that will help to increase Sweet Home's overall mitigation capability.

Hazard Profile

The DOGAMI Multi-Hazard Risk Assessment (MHRA) analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the following tables. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table SH-3. City of Sweet Home Hazard Profile

Community Overview							
Community Name		Population	Number of Buildings	Critical Facilities[1]		Total Building Value ($)	
Sweet Home		10,028	6,313	10		1,466,569,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	55	0.5%	39	0	796,000	0.1%
Earthquake*	CSZ Mw-9.0 Deterministic	64	0.6%	334	0	42,142,096	2.9%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	14	0.1%	53	0	12,507,581	0.9%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	276	2.7%	170	0	33,736,000	2.3%
Wildfire	High and Moderate Risk	833	8.3%	516	1	100,826,000	6.9%

[1]Facilities with multiple buildings were consolidated into one building complex.
[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).
*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.
Source: DOGAMI Multi-Hazard Risk Report, 2024

Table SH-4. City of Sweet Home Critical Facilities

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Foster Elementary School	-	-	-	-	-	-	-
Hawthorne Elementary School	-	-	-	-	-	-	-
Oak Heights Elementary School	-	-	-	-	-	-	-
Sweet Home Fire and Ambulance No.21	-	-	-	-	-	-	-
Sweet Home Fire and Ambulance Station 22	-	-	-	-	-	-	-
Sweet Home High School	-	-	-	-	-	-	-
Sweet Home Junior High School	-	-	-	-	-	X	-
Sweet Home Police Department	-	-	-	-	-	-	-
City of Sweet Home	-	-	-	-	-	-	-
Willamette National Forest – Sweet Home Ranger District	-	-	-	-	-	-	-

Source: DOGAMI Multi-Hazard Risk Report, 2024

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the jurisdiction representatives first updated the description, type, location, and extent of each hazard. The City of Sweet Home representatives joined the process after the Steering Committee had used the Hazard Analysis Methodology exercise to rank the potential impact on the county as a whole. The results of that exercise are provided in Table SH-5.

In this analysis, severity ratings, and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability as shown in the table below. See Volume I, Section 2, Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability accounts for approximately 40%.

This method provides the jurisdictions with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused on where the risk is greatest.

The City of Sweet Home representatives refined the risk assessment during discussion with the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table SH-6 below represents the variation in total risk to the natural hazards as experienced by the City of Sweet Home representatives compared to the county level ranking completed by the Steering Committee.

The city ranked Winter Storm/Ice Storm and Smoke/Poor Air Quality as highly impactful hazards like the county did. The City of Sweet Home representatives ranked Wildfire higher than the county did, elevating it to the second or third most important hazard for the city. Extreme Heat was not as highly ranked due to the elevation and cooler climate in Sweet Home. Neither is Drought a high concern for the city.

Dam Failure is ranked more highly than the county ranking, due to the proximity of several federal and non-federal dams to Sweet Home. Windstorm and Tornado are also more highly ranked by the city based on the role of these winds in the 2020 wildfires and their impact on the city.

Table SH-5. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table SH-6. Relative Ranking of Hazards for Sweet Home

	Total Score	
Hazard	**County**	**Sweet Home**
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	↓↓
Smoke/Poor Air Quality	183.5	same
Flood	171.3	same
Drought	169.0	↓
Earthquake (Cascadia)	160.7	same
Wildfire	158.9	↑
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	↑
Windstorm/Tornado	116.5	↑
Volcano	109.0	same
Landslide and Avalanche	106.4	same

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Sweet Home. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Sweet Home Hazard Profile and Critical Facilities tables (SH-3 and SH-4) included above, this section identifies Events since the last plan update and vulnerabilities specific to Sweet Home, recent localized hazard events and impacts, and illustrates the basis for the city's HVA scores.

Dam Failure

Events: None.

Vulnerability and Impacts: Sweet Home is adjacent to High Hazard Potential Dams, both federal and non-federal. Likelihood is low, but maximum threat is very high.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018, and 2021-2023.

Vulnerability and Impacts: Sweet Home's water source is not in jeopardy. However, there is a concern that in the future if there is less rainfall than usual, especially if prolonged across

several years, that coincides with the annual drawdown of Green Peter Reservoir, there could potentially be an impact to water supply.

Earthquake (Crustal)

Events: One event in 2022 (October) reported by the USGS as a 4.4-magnitude quake centered about 9 miles east/southeast of Lacomb was felt in Sweet Home. No damage was reported.[40]

Vulnerability and Impacts: Older building stock is a concern.

Earthquake (Cascadia)

Events: None.

Vulnerability and Impacts: Older building stock is a concern.

Extreme Heat

Events: Excessive heat and high heat events in 2017, 2021, and 2022. These occurrences were noted, but did not result in people needing assistance.

Vulnerability and Impacts: Currently limited vulnerability based on the usage of the Police Department during extreme heat events.

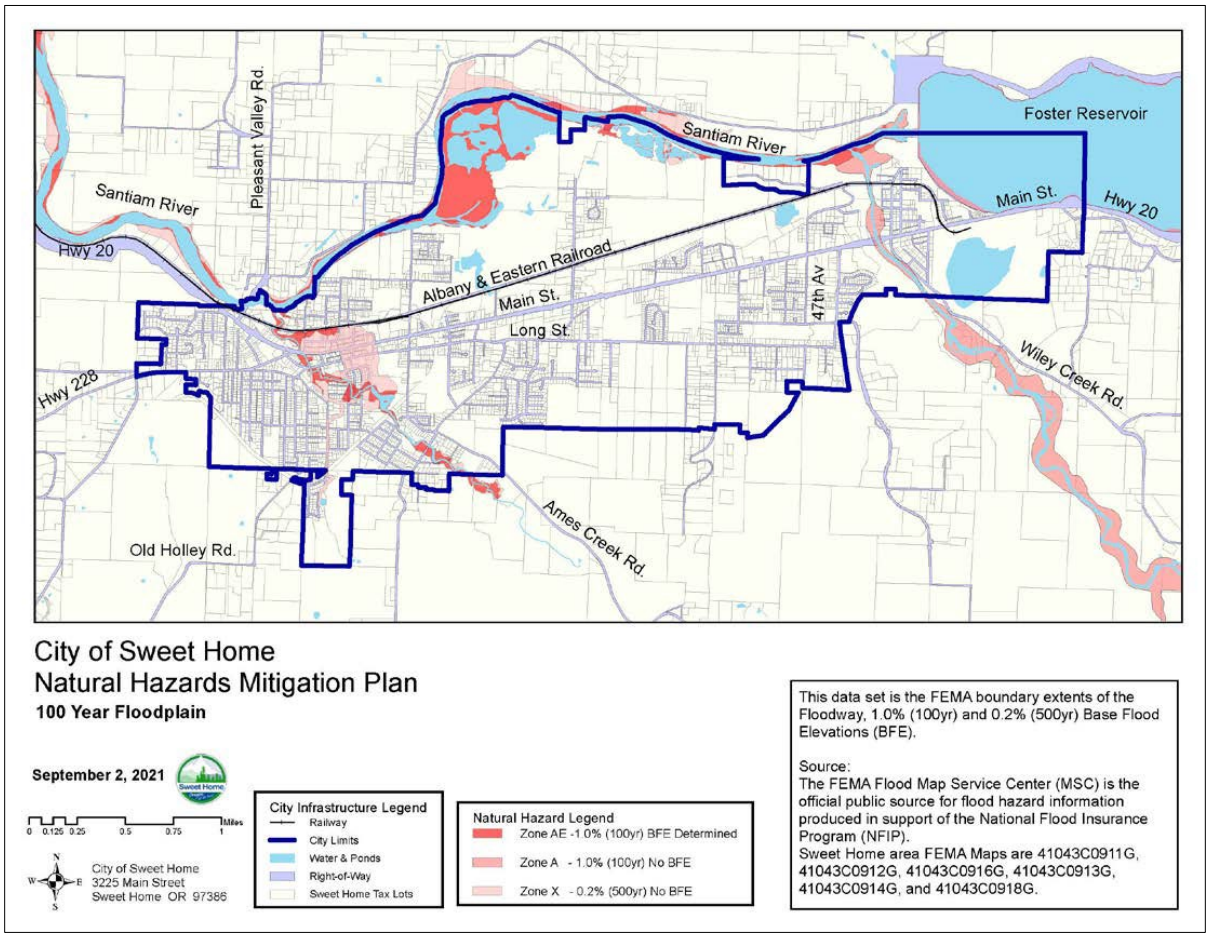
Flood

Events: None since 2022. The principal types of flood that occur in Sweet Home include riverine floods. Flash floods can also occur. The Santiam River is located on the north side of Sweet Home. There is also localized flooding in heavy rain events.

Vulnerability and Impacts: The most significant of the FEMA-determined floodplains and floodways near Sweet Home surround the Santiam River and the tributaries. Sweet Home and unincorporated areas could also be affected by flood runoff from the relatively steep areas nearby. Culvert/ditch areas and dam inundation areas are related hazards of concern.

[40] https://www.lebanonlocalnews.com/earthquake-shakes-lebanon-east-linn-county/

Figure SH-4. Special Flood Hazard Area in Sweet Home



Source: City of Sweet Home Natural Hazards Mitigation Plan, September 2021

Landslide/Avalanche

Events: None.

Vulnerability and Impacts: Sweet Home is at low risk for landslide activity. Outside of the city limits, a large number of buildings are exposed to Very High landslide hazard between Lebanon and Sweet Home due to steep slopes in the South Santiam River valley. One community lifeline facility, an elder care facility, was identified by DOGAMI as being exposed to High and Very High landslide susceptibility.

Smoke/Poor Air Quality

Events: This hazard has occurred every year since 2020 for at least a part of the summer.

Vulnerability and Impacts: Smoke and poor air quality present a public health risk.

Volcano

Events: None.

Vulnerability and Impacts: Increased sediment and high turbidity from ash falls at the wastewater treatment plant are a potential concern.

Wildfire

Events: The September 2020 wildfires were the largest wildfire event in the county, and Sweet Home was indirectly affected by evacuees and by smoke. There have been several other fires to the east of the city since 2020.

Vulnerability and Impacts: 23% of the Sweet Home Fire District, which covers the city and surrounding unincorporated areas, is in the Wildland Urban Interface. A significant number of buildings are exposed to High or Moderate wildfire hazard, including Sweet Home Junior High School. The Fire District started a Community Wildfire Risk Reduction Program after the 2020 wildfires to help the community and surrounding areas prepare for and prevent wildfires.

Winter Storm/Ice Storm

Events: These events regularly affected Sweet Home, including several winter storms and a notable ice storm in February 2021 (DR-4599) and January 2024 (DR-4768).

Vulnerability and Impacts: Trees and power lines are vulnerable to winter and ice storms. These storms also lead to loss of ability to access critical services and retail. There are some privately owned streets in Sweet Home that are challenging to access in severe ice events.

Windstorm/Tornado

Events: Straight line winds during the September 2020 wildfires.

Vulnerability and Impacts: Trees and power lines are vulnerable to windstorms.

Mitigation Strategy

During the 2023-2024 Linn County and Sweet Home NHMP update process, the DLCD planner and Sweet Home representatives assessed the mitigation strategy actions within the 2021 Sweet Home Natural Hazards Mitigation Plan. Together they revised and updated that list of actions to reflect the revised risk assessment for the City of Sweet Home.

Table SH-7. Completed Actions – Sweet Home

Mitigation Action	Action Title	Coordinating Organization	Partner Organizations	2017 Timeline	2024 Status	Notes
Multi-Hazard #1	Integrate hazard, vulnerability, and risk findings in the NHMP into enhanced emergency operations planning.	Sweet Home Emergency Management Committee		Long-Term	Complete	
Severe Storm #1	Assess the need for back-up power generators for emergency shelters in Sweet Home. Identify the specifications that are needed to have a generator be appropriate for that shelter. See also the Critical Infrastructure List in the Sweet Home NHMP.	Sweet Home Emergency Management Committee	Police, Sweet Home Fire and Ambulance District, American Red Cross, Sweet Home Public Schools	Short-Term	Complete	
Flood #3	Complete the inventory and mapping of locations in Sweet Home subject to frequent storm water flooding.	CCDD, Public Works	Sweet Home Emergency Management Committee	Short-Term	Complete	
Wildfire #1	Identify and map evacuation routes and procedures for high-risk areas, disseminate and educate the public. See the evacuation map in the Sweet Home NHMP. See also the Emergency Operations Plan.	City Engineering, Police, Sweet Home Fire and Ambulance District, ODF	See also the 2022 NHMP Outreach Calendar.	Short-Term	Complete	

Table SH-8. Actions Removed from the Sweet Home Addendum

Mitigation Action	Description	Coordinating Organization	Partner Organizations	2017 Timeline	2024 Status	Notes
Multi-Hazard #2	Identify and pursue funding opportunities to implement mitigation actions in the Sweet Home NHMP. Mitigation actions are prioritized as high, medium, and low.	CCDD, SHFAD	Sweet Home Emergency Management Committee	Short-Term	Remove	Staff feels this is obvious and may not need to be included as an explicit action, because it is so broad.
Multi-Hazard #6	Identify and promote public & private sector partnerships to foster hazard mitigation activities.	Sweet Home Emergency Management Committee	Pacific Power, Energy Trust, See also the 2022 NHMP Outreach Calendar.	Short-Term	Remove	Staff felt this was too vague as an action.
Severe Storm #1	Consider upgrading lines & poles to improve wind/ice loading, undergrounding critical lines, and adding interconnect switches to allow alternative feed paths and disconnect switches to minimize outage areas.	Electrical Utility (PPL)	Sweet Home Emergency Management Committee	Long-Term	Remove	Dependent on an outside utility.
Severe Storm #2	Encourage Pacific Power (PPL) to prioritize a coordinated emergency response (including enhanced communications) with City Public Works.	CPWD; CCDD, PPL	Sweet Home Emergency Management Committee	Long-Term	Remove	Not a city function

Mitigation Action	Description	Coordinating Organization	Partner Organizations	2017 Timeline	2024 Status	Notes
Severe Storm #4	Continue tree trimming efforts to mitigate electrical hazards, especially for transmission lines and trunk distribution lines.	PPL, City Public Works, City Park and Tree Committee	Sweet Home Fire and Ambulance	Long-Term	Remove	Not a city function
Severe Storm #5	Continue City-wide efforts encouraging property owners to keep trees trimmed near their electrical service drops.	Sweet Home Emergency Management Committee, City Park and Tree Committee	CCDD, Sweet Home Fire and Ambulance, see also the 2022 NHMP Outreach Calendar.	Long-Term	Remove	
Wildfire #1	Review and identify information to determine what to use. Encourage fire-safe construction practices for existing and new construction in high- risk areas. In particular, look at the city's perimeter.	Sweet Home Emergency Management Committee	CCDD, SHFAD, ODF	Long-Term	Remove	Fire District is now involved in fire-related discussions during permitting / construction
Flood #2	Encourage US Corps of Engineers to complete seismic vulnerability assessments for Green Peter and Foster dams make seismic improvements as necessary.	USACE, CCDD, Police, Public Works, Sweet Home Fire and Ambulance District	Sweet Home Emergency Management Committee	Short-Term	Remove	This is outside the city's purview, reliant on federal government
Flood #1	Periodically evaluate elevation data for number of structures within the 100-yr floodplain. Coordinate with Linn County Planning each year on obtaining	CCDD, Linn County	Sweet Home Emergency Management Committee	Long-Term	Remove	

Mitigation Action	Description	Coordinating Organization	Partner Organizations	2017 Timeline	2024 Status	Notes
	and using LIDAR imaging for elevation information.					
Flood #3	Identify and evaluation locations with repetitive flooding and significant damages or road closures. Determine and implement mitigation remedies.	CPWD, CCDD	Sweet Home Emergency Management Committee	Long-Term	Remove	This seems overly broad; staff preference to remove
Flood #4	Obtain building database from Linn County each year.	CCDD, Linn County	Sweet Home Emergency Management Committee	Long-Term	Remove	
Flood #5	Obtain LIDAR data for floodplain areas every three years.	CCDD, Linn County	Sweet Home Emergency Management Committee	Long-Term	Remove	
Earthquake #4	Every year, check the building permit records to ascertain which buildings have had seismic upgrades.	CCDD	Sweet Home Emergency Management Committee	Long-Term	Remove	
Landslide #1	Consider geotechnical evaluation and appropriate mitigation actions for landslides during review of proposed development.	CCDD, CPWD	Sweet Home Emergency Management Committee, DOGAMI, DLCD	Long-Term	Remove	Combined with Landslide 2, retained/revised, below
Multi-Hazard #3	Identify and promote education programs for mitigating hazard risks.	Sweet Home Emergency Management Committee	See also the 2022 NHMP Outreach Calendar.	Long-Term	Remove	Combined with Multi-Hazard 1 retained/revised, below

Table SH-9. Ongoing, Short-, and Long-Term Projects – Sweet Home

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Organization	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 1	Maintain a City Web Page and social media for emergency preparedness information and links for the public. Identify and promote education programs for mitigating hazard risks.	CCDD; Sweet Home Emergency Management Committee		Ongoing	Retain, revised	Existing City budget	Revised, webpage has been completed and addition of education programs. Webpage maintenance will continue ongoing. Information/links are verified regularly.
Multi-Hazard 2	Evaluate and develop detailed inventories of at- risk buildings and infrastructure and refine priorities for mitigation actions. Use the Critical Infrastructure List in the Sweet Home NHMP and the DOGAMI MHRA database.	City Community Development Department (CCDD)	Sweet Home Public Schools, Sweet Home Fire and Ambulance District	Short term	Retain	City, grants, see also the Grant Programs and Resources appendix	
Multi-Hazard 3	Continue the formal role for the Sweet Home Emergency Management Committee to maintain a sustainable process to encourage, implement, monitor, & evaluate city-wide mitigation actions. Review mitigation actions 2x year.	Sweet Home Emergency Management Committee	See also the 2022 NHMP Outreach Calendar.	Long term	Retain	Existing City budget	

Hazard Action Item	Action Title	Coordinating Organization	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 4	Provide educational information to existing neighborhood groups to enable them to better help their close neighbors during hazard emergencies and to notify emergency response officials if assistance is needed. See the 2022 NHMP Outreach Calendar.	Sweet Home Emergency Management Committee		Short term	Retain	Existing City budget	Efforts were paused during covid and have not resumed in full.
Multi-Hazard 5	Integrate the NHMP information into planning and regulatory documents and programs.	CCDD	Sweet Home Emergency Management Committee	Long term	Retain	Existing City budget	
Multi-Hazard 6	Reach out to Sweet Home Public Schools to improve and increase information sharing and collaboration on mitigation of natural hazards.	Sweet Home Emergency Management Committee, Sweet Home Public Schools	Police and Sweet Home Fire and Ambulance District	Long term	Retain	Existing City budget	
Multi-Hazard 7	Identify, promote, and make available personal preparedness programs for Sweet Home residents. Revisit the 2022 Outreach Calendar.	Sweet Home Emergency Management Committee		Short term	Retain, revise	Existing City budget, grant	Addition to revisit the 2022 NHMP Outreach Calendar.

Hazard Action Item	Action Title	Coordinating Organization	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Earthquake 1	Obtain and make information available to the public about structural and non-structural retrofitting of vulnerable homes and encourage retrofits.	CCDD, Sweet Home Emergency Management Committee	Sweet Home School District, see also the 2022 NHMP Outreach Calendar	Ongoing	Retain	Existing City budget	Verified CCDD has info to provide to the public
Earthquake 2	Perform an inventory of buildings that may be particularly vulnerable to earthquake damage using most current techniques. See the Critical Infrastructure List in the Sweet Home NHMP.	CCDD, Sweet Home Emergency Management Committee	Sweet Home School District	Long term	Retain	Existing City budget, Sweet Home School District, FEMA	
Earthquake 3	Complete inventory of residential and commercial buildings that may be vulnerable to earthquake damage, including pre- 1940s homes, unreinforced masonry buildings, tilt-up buildings, and buildings with soft first stories.	CCDD	Sweet Home Emergency Management Committee	Long term	Retain	Existing City budget, FEMA	
Earthquake 4	Seek funding to retrofit important public facilities with significant seismic vulnerabilities. See Critical Facilities List in the Sweet Home NHMP.	CPWD, CCDD, Sweet Home Emergency Management Committee		Long term	Retain	Existing City budget, FEMA	

Hazard Action Item	Action Title	Coordinating Organization	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Flood 1 / Dam Safety	Obtain maps of dam failure inundation areas and update Sweet Home Emergency Operations Plan. Dam inundation info now available online; need to review EOP.	USACE, CCDD, Police, Public Works, SHFAD	Sweet Home Emergency Management Committee	Short term	Retain	USACE	
Flood 2	For structures within the 100-year floodplain, explore mitigation options with property owners.	CCDD	Sweet Home Emergency Manager and Emergency Management Committee	Ongoing	Retain	Existing City budget	May want to consider outreach program to those in floodplain
Landslide 1	Review existing identified landslide hazard areas mapped by the City. Review and evaluate newer landslide information such as SLIDO and the landslide susceptibility maps from DOGAMI. Consider adoption and integration of newer landslide information into existing City codes and maps, and the comprehensive plan.	CPWD, CCDD	Sweet Home Emergency Management Committee, DOGAMI, DLCD	Short term	Retain	Existing City budget, FEMA	

Hazard Action Item	Action Title	Coordinating Organization	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Landslide 2	Use the information identified in Short-Term LS #1 to review the UGB expansion areas for landslide hazards. Use information identified in LS#1 to consider geotechnical evaluation and appropriate mitigation actions for landslides during review of proposed development.	CCDD	Sweet Home Emergency Management Committee, DOGAMI, DLCD	Long term	Retain, revised	Existing City budget	Revised to include actions related to development review (Landslide 1 removed above).
Severe Storm 1	Identify critical need locations, vulnerable populations, and vulnerable independent individuals. See also the Critical Infrastructure List in the Sweet Home NHMP.	CCDD, Sweet Home Emergency Management Committee	Police, Sweet Home Fire and Ambulance District, American Red Cross, Sweet Home Public Schools	Short term	Retain	Existing City budget	
Severe Storm 2	Assess needs for back-up power generators for all City-owned designated critical facilities (See the Critical Infrastructure List in the NHMP) and ensure that the highest priority critical facilities have generators or are wired to accept “plug-in generators”.	CPWD, Police, Fire,	Sweet Home Emergency Management Committee	Long term	Retain	Existing City budget	In progress

Hazard Action Item	Action Title	Coordinating Organization	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Volcano 1	Evaluate capability of the water treatment plant to deal with high turbidity from ash falls. Include volcanic hazards in the Sweet Home Emergency Operations Plan and water treatment plant operations plan.	CPWD		Short term	Retain	Existing City budget	Turbidity evaluation complete; need to review EOP & WTPOP
Wildfire 1	Obtain better information about existing fuels reduction projects. Identify hazard areas and provide public education for them, especially the high hazard areas. Efforts will be on- going since fuels grow back.	Sweet Home Emergency Management Committee,	CCDD, Sweet Home Fire District, ODF	Ongoing	Retain	OSFM, ODF	

Plan Implementation and Maintenance

The Sweet Home City Council is responsible for adopting the Linn County MJ-NHMP including the City of Sweet Home Addendum to the Linn County MJ-NHMP. The City Manager or their designee is responsible for coordinating implementation and maintenance of the Sweet Home Addendum to the Linn County MJ-NHMP and will participate in the Linn County MJ-NHMP implementation and maintenance meetings. The Sweet Home representative will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of Sweet Home's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. Sweet Home is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, Sweet Home will also review and update its addendum. The Sweet Home Convener will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Sweet Home's Convener determine what components of the mitigation plan need updating.

CITY OF TANGENT ADDENDUM

Purpose

This document serves as the City of Tangent's Addendum to the Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan (MJ-NHMP, NHMP). The purpose of this addendum is to guide the implementation of mitigation actions by Tangent to improve the resilience of the community. Please note that mitigation planning is a long-term endeavor—one that requires broad internal involvement and community engagement to be successful. Finally, please refer to the information contained in Volume I (Basic Plan) of this NHMP which serves as the plan foundation and Volume III which provides additional supporting information for the plan.

Plan Process, Participation, and Adoption

Tangent participated in the Linn County MJ-NHMP for the first time during the 2017 update of the natural hazard mitigation plan.

During 2023 and 2024, Linn County partnered with the Oregon Department of Land Conservation and Development (DLCD) and the Oregon Department of Emergency Management (ODEM), and Linn County cities, including Tangent, to update their addenda to the Linn County Natural Hazard Mitigation Plan, which expired May 23, 2023.

By developing this addendum to the Linn County MJ-NHMP, locally adopting it, and having it approved by FEMA, the City of Tangent will gain eligibility for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure and Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. This project is funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP-5327-05-P-DLCD).

The City of Tangent joined the Linn County MJ-NHMP update by executing an intergovernmental agreement with DLCD on 3/14/2024. On 3/13/2024, 4/3/2024, 7/17/2024, and 10/23/2024, Tangent City Manager, Joe Samaniego participated in meetings facilitated by DLCD, including to conduct a risk assessment exercise with other county jurisdictions that included a Hazard Vulnerability Assessment ranking. City staff met again with DLCD on 2/27/2024 and 8/9/2024 to update this addendum.

Tangent staff promoted the NHMP survey and outreach efforts throughout the plan update. The City Council was informed about the survey, and the city posted a link to the survey on its website for a week and in the email listserv of residents who signed up. The City's National Night Out event also had fliers on August 6, 2024.

The Linn County MJ-NHMP was approved by FEMA on [Month] [Day], 2025 and the Tangent Addendum was adopted via resolution on [Month] [Day], 2025. This NHMP is effective through [Month] [Day], 2030.

The Linn County NHMP, and Tangent Addendum, are the result of a collaborative effort between residents, public agencies, non-profit organizations, the private sector, and regional organizations. Public officials, including Tangent's City Manager and the Tangent Rural Fire District Fire Chief, guided the process of developing the plan. For more information on all parties involved in the planning process, see the Acknowledgements and Plan Summary sections, and Appendix A: Planning and Public Process.

The Tangent City Manager is the designated convener of this addendum. The Convener will take the lead in implementing, maintaining, and updating the addendum to the Linn County NHMP in collaboration with Linn County.

The Tangent City Manager and the DLCD Project Manager revised the Tangent Addendum with particular focus on the plan's hazard history, risk assessment, and mitigation strategy. During the update process City staff and survey participants provided additional information on potential funding sources, action item prioritization, and local resource and capacity restraints.

The City of Tangent advisory group included the following individuals:

- Joe Samaniego, City Manager
- Chris Griffin, Fire Chief, Tangent Rural Fire District

Tangent city staff used multiple approaches to engage the public, as described above. The advisory group was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. In addition, community members outside of the steering committee were provided an opportunity for comment via the plan review process (see Appendix A for more information).

The convener for Tangent will also remain active in the county's implementation and plan maintenance process (see Volume I, Section 4 for more information).

Risk Assessment

A risk assessment is intended to provide the "factual basis for activities proposed in the strategy to reduce losses from identified hazards."[41] This section of the NHMP addendum in conjunction with the county-wide risk assessment in Volume I can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – *Areas Subject to Natural Hazards*.

Community Profile

This section provides information on city specific assets and populations. For additional information on the characteristics of Tangent, in terms of geography, environment, population, demographics, employment and economics, and housing and transportation, see Volume III, Appendix B: Community Profile. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

[41] 44 CFR 201.6(2)(i)

Community Characteristics

Tangent is located in the Willamette Valley of Linn County, Oregon, about one mile south of Albany's city limits. The city is approximately three miles west of Interstate 5 and is bisected by Highway 99E and Highway 34. Tangent has 3.78 square miles of land area. Water features include Lake Creek on the southwest side of the city, North Lake Creek which passes through the center, and Oak Creek which passes through the north end of Tangent. Surface water and seasonal creeks all drain into the Calapooia River located just outside the city's western boundary. Tangent has a flat terrain and the landscape surrounding the city is primarily agriculture with some limited industrial sites in the north.

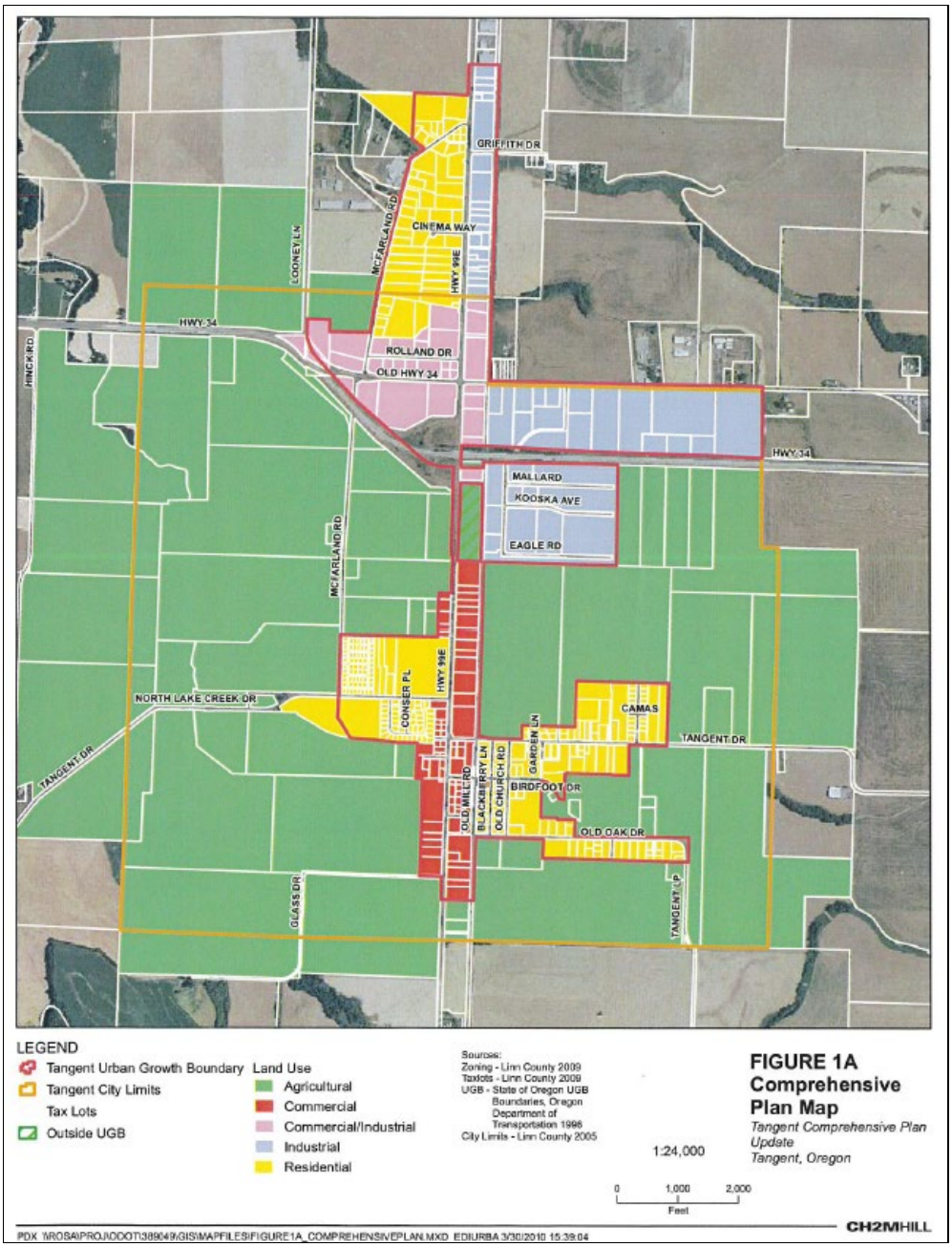
Tangent experiences a temperate climate with warm dry summers and mild wet winters. Over the course of the year, the temperature typically varies from 36°F to 87°F and is rarely below 25°F or above 98°F. The wetter season typically lasts 7 months, from October to May, with a greater than 31% chance of a given day being a wet day. The month with the most wet days in Tangent is November, with an average of 16.5 days with at least 0.04 inches of precipitation. Annually, the city receives an average of 43 inches of precipitation.

The Population Research Center at Portland State University lists Tangent's 2023 population at 1,218. This represents a minimal decrease from 2020 (1,232). Population grew less than one percent from 2015 to 2023. For more demographic information, refer to Appendix B.

Tangent is known for its agricultural activities and cultivation of grass seed.[42] However, there has been a shift away from agricultural activities and present-day Tangent has become a bedroom community for Albany and Corvallis. Of Tangent's residents who are in the workforce, the vast majority work outside of Tangent; however, many workers also commute into Tangent for jobs.[43] Most jobs in Tangent are in construction (34%), services (29%), and wholesale trade (14%).[44] Median household income in Tangent in 2022 was $53,985, lower than the median household income for Linn County at $69,523. For more economic information, refer to Appendix B.

[42] City of Tangent Comprehensive Plan 2007: Cultural Resources: Historical Profile, p 52.
[43] US Census Bureau. Longitudinal Employer-Household Dynamics – On the Map. Inflow-Outflow Analysis for Tangent, OR, (2014 data). https://onthemap.ces.census.gov/, accessed September 2017.
[44] Business Oregon – Oregon Prospector. Total Employees by Major SIC (2017) for Tangent, OR. http://oregon.zoomprospector.com/

Figure TG-1. Tangent Comprehensive Plan Map



Source: City of Tangent, https://www.tangentor.gov/land-and-use-development

Critical and Important Facilities

Tangent's critical and important facilities include the following:

- City Hall, 32166 Old Oak Dr., Tangent, OR 97389
- Tangent Rural Fire District, 32053 Birdfoot Dr., Tangent, OR 97389

Tangent is part of the Greater Albany Public School District 8J. There are currently two schools which serve the community from within the city limits (one public, one private):

- Central Valley Christian School, 31630 OR-34, Tangent, OR 97389
- Tangent Elementary School, 32100 Old Oak Dr., Tangent, OR 97389

The following private facility could also provide service to residents as an emergency shelter provided agreements with the facility are put in place for such use:

- Central Electrical Training Center, 33309 OR-99E, Tangent, OR 97389 (could be used as an emergency shelter)

Private facilities that provide community lifeline support are analyzed in the DOGAMI Multi-Hazard Risk Report, Appendix E; see section 2.4 and Table C-3. Lifeline Risk by Linn County Community for more information. The DOGAMI analysis identified a high occupancy building, but it was not found to be vulnerable.

Transportation

Tangent is easily accessible by a few highway connections that run through or near the city. Highway 34 is the main east-west highway that connects Tangent with Corvallis to the west and Interstate 5 to the east. Highway 99E is the major north-south highway that connects Tangent with Albany to the north and Shedd and Halsey to the south.

Road	Owner	Notes
OR-99E	ODOT	North/South route within the city
OR-34	ODOT	East/West route within the city
Railroad	Union Pacific	Runs North/South to the east of 99E

There are three railroad crossings in Tangent: Old Highway 34, Birdfoot Drive, and Tangent Drive. The Fire Department is near the Birdfoot Drive crossing. There is potential for travel disruption in the southern part of town where two of the crossings are located.

Energy

Electric utilities in Tangent are provided by Pacific Power (PacificCorp) and natural gas is provided by NW Natural. The City does not have backup power for critical facilities.

Water/Wastewater

Tangent provides sewer services for residents. Drinking water for residents is provided through individual wells.[45] The potential for contamination after a natural disaster is high for well water. It is also important to maintain the structural integrity of the sewer system after a natural disaster to prevent pollution or a public health emergency.

Emergency Services

The Tangent Rural Fire District provides emergency services in Tangent. The nearest hospital to Tangent is Samaritan Albany General Hospital in Albany.

[45] City of Tangent Comprehensive Plan 2007: City Services, p 61.

Community Assets, Vulnerable Populations, and Plans and Policies

Cultural/Historical Resources

There are no cultural or historical resources listed in Tangent. However, the Bass Farm and Bass Estate (City Hall) have a historical connection.

Functional and Access Needs of Vulnerable Populations

Tangent has a fairly stable population size with little change during the planning period. Population distribution among the age groups is steeply skewed toward the young or the elderly. However, Tangent has higher than the county average percentage of households including one or more children under 18.

Tangent is among the cities in Linn County with people who speak English less than "very well," emphasizing the importance of communicating in other languages in the community. Hispanic or Latino people make up 11.5% of Tangent, slightly higher than the average for Linn County (9.8%). For more demographic information, refer to Appendix B: Community Profile.

Plans and Policies

The Tangent Comprehensive Plan was first acknowledged by the Oregon Land Conservation and Development Commission in 1985. The City last amended the plan in 2010. The City implements the plan through the City of Tangent Land Use Development Code, which was last revised in 2018.

Tangent currently maintains the following plans that relate to natural hazard mitigation. The City's website provides easy access to these documents.

- Comprehensive Plan (2010)
- Land Use Development Code (2018), in particular the Flood Damage Prevention Ordinance (2010)
- Transportation System Plan (2010)
- Public Works Standards for Design and Construction (2022), including Stormwater Master section

In addition to integration through existing plans and policies to achieve mitigation, further described in Section 4: Plan Implementation and Maintenance, continued coordination during the Plan Maintenance period between the county and jurisdictions will help to expand and improve the mitigation capabilities of all. Close coordination will provide opportunities for evaluating potential funding opportunities to accomplish collaborative mitigation actions as well as specific mitigation actions outlined in the city's mitigation strategy. The county has the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively. Additionally, the city has identified mitigations actions that will help to increase Tangent's overall mitigation capability.

Hazard Profile

The DOGAMI Multi-Hazard Risk Assessment (MHRA) Report analyzed the exposure and potential losses from two earthquake scenarios, a 100-year flood scenario, exposure to landslide, channel migration, wildfire, and volcanic lahar, shown in the following tables. The methods used for this analysis are available in the report provided as Appendix E to this plan.

Table TG-1. City of Tangent Hazard Profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Tangent		1,218	1,064		4	407,086,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	4	0.3%	9	0	113,000	0%
Earthquake*	CSZ Mw-9.0 Deterministic	78	6.4%	316	1	53,119,121	13%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	19	1.5%	102	0	21,919,532	5.4%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	31	2.5%	32	0	7,049,000	1.7%

[1]Facilities with multiple buildings were consolidated into one building complex.
[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).
*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.
Source: DOGAMI MHRA Report, 2024

Table TG-2. Critical Facilities for Tangent

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Central Valley Christian School	-	-	-	-	-
Tangent City Hall	-	-	-	-	-
Tangent Elementary School	-	X	-	-	-
Tangent RFPD*	-	-	-	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.
Source: DOGAMI MHRA Report, 2024

Hazard Analysis

The methodology for assessing risk was the same for all jurisdictions and a detailed description of the Hazard Analysis Methodology can be found in Volume I. A brief description is provided below. To complete the risk assessment, the jurisdiction representatives first updated the description, type, location, and extent of each hazard. Next, they updated the Hazard Analysis Methodology based on each hazard's potential impact on the county as a whole. The results of that exercise are provided in Table TG-3.

In this analysis, severity ratings and weight factors are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability, as shown in the table below. See Volume I, Section 2, Risk Assessment for more information.

The methodology produces scores ranging from 24 (lowest possible) to 240 (highest possible). Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

This method provides the jurisdictions with a sense of hazard priorities, or relative risk. It does not predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

The City of Tangent representatives refined the risk assessment with guidance from the DLCD planner using the County's Hazard Analysis Methodology scores as a reference. Table TG-4, below, represents the variation in total risk to the natural hazards as experienced in the City of Tangent compared to the county level ranking completed by the Steering Committee.

Winter Storm, which was revised in 2024 to include Ice Storms, retains the top rank among hazards for the county and the city. Extreme Heat and Smoke/Poor Air Quality (both newly identified hazards in this update) also rank most highly from the perspective of the City of Tangent staff.

Wildfire is a lower concern to the city than it was ranked by the county. This is true as well for the risks posed by Drought and by Flooding.

The city does not consider Dam Failure, Landslide, or Volcano to be hazards that require mitigation action by the city and as such do not identify mitigation actions for those hazards.

Table TG-3. OEM Hazard Analysis Methodology County Level Risk Scores

Linn County
2024 Natural Hazard Vulnerability Assessment Rankings
Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	weight	severity score	subtotal	
Winter Storm/Ice Storm	2 x	**8.1**	16.2	7 x	**9.0**	63.0	5 x	**9.0**	45.0	10 x	**7.7**	77.0	**201**
Extreme Heat	2 x	**7.5**	15.0	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**7.3**	73.0	**187**
Smoke/Poor Air Quality	2 x	**8.1**	16.2	7 x	**8.4**	58.8	5 x	**8.1**	40.5	10 x	**6.8**	68.0	**184**
Flood	2 x	**7.3**	14.6	7 x	**8.1**	56.7	5 x	**6.4**	32.0	10 x	**6.8**	68.0	**171**
Drought	2 x	**7.0**	14.0	7 x	**7.5**	52.5	5 x	**5.9**	29.5	10 x	**7.3**	73.0	**169**
Earthquake (Cascadia)	2 x	**2.0**	4.0	7 x	**4.6**	32.2	5 x	**7.7**	38.5	10 x	**8.6**	86.0	**161**
Wildfire	2 x	**7.5**	15.0	7 x	**8.7**	60.9	5 x	**6.4**	32.0	10 x	**5.1**	51.0	**159**
Earthquake (Crustal)	2 x	**4.3**	8.6	7 x	**5.8**	40.6	5 x	**7.7**	38.5	10 x	**6.8**	68.0	**156**
Dam Failure	2 x	**2.3**	4.6	7 x	**2.6**	18.2	5 x	**6.8**	34.0	10 x	**7.7**	77.0	**134**
Windstorm/Tornado	2 x	**4.9**	9.8	7 x	**5.6**	39.2	5 x	**5.1**	25.5	10 x	**4.2**	42.0	**117**
Volcano	2 x	**2.0**	4.0	7 x	**2.0**	14.0	5 x	**6.4**	32.0	10 x	**5.9**	59.0	**109**
Landslide and Avalanche	2 x	**4.8**	9.6	7 x	**6.4**	44.8	5 x	**3.8**	19.0	10 x	**3.3**	33.0	**106**

Completed by the Linn County NHMP update Steering Committee during 2024.

Table TG-4. Relative Risk of Natural Hazards in Tangent

	Total Score	
HAZARD	**County**	**Tangent**
Winter Storm/Ice Storm	201.2	same
Extreme Heat	187.3	same
Smoke/Poor Air Quality	183.5	same
Flood	171.3	↓
Drought	169.0	↓
Earthquake (Cascadia)	160.7	same
Wildfire	158.9	↓
Earthquake (Crustal)	155.7	same
Dam Failure	133.8	n/a
Windstorm/Tornado	116.5	same
Volcano	109.0	n/a
Landslide and Avalanche	106.4	n/a

Hazard Characteristics

Hazard History, Characteristics and Extent for Linn County apply also to Tangent. Volume I, Section 2, Risk Assessment, adequately describes the characteristics of natural hazards, as well as the location and extent of potential events. In addition to the City of Tangent Hazard Profile and Critical Facilities tables (TG-1 and TG-2) included above, this section identifies vulnerabilities specific to Tangent, recent localized hazard events and impacts, and illustrates the basis for the city's HVA scores.

Drought

Events: Portions of Linn County experienced Extreme Drought in 2018 and 2021-2023.

Vulnerability and Impacts: Those who rely on regular precipitation for dry land farmed agricultural crops may be the most vulnerable to drought conditions. Drought can also impact tree health throughout the community.

Earthquake

Events: None.

Vulnerability and Impacts: The Tangent Elementary School, part of the Greater Albany Public School District 8J, is vulnerable to a CSZ 9.0 Earthquake.

Extreme Heat

Events: Excessive heat and high heat events in 2017, 2021, and 2022.

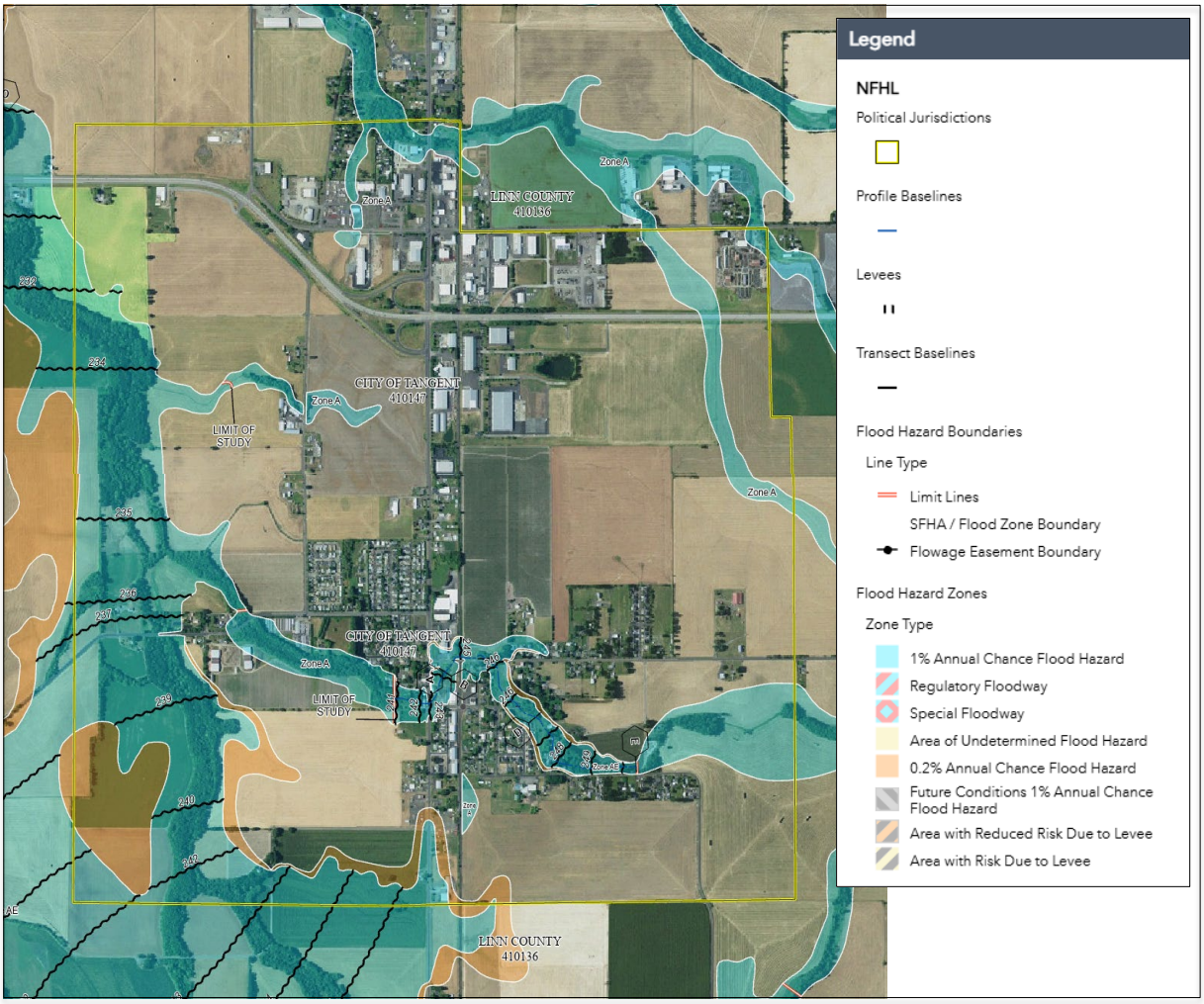
Vulnerability and Impacts: During the “heat dome” of 2021 the lack of air conditioning for some became a concern. People were directed to cooling centers in Albany and Lebanon. The air conditioning at Tangent City Hall worked hard to keep that facility cool during the 2021 event.

Flood

Events: In 2021-2022 there was a flooding incident on North Lake Creek Dr. east of the city.

Vulnerability and Impacts: Transportation routes were impacted by this event. Flood hazard zones are shown in the following figure.

Figure TG-2. Special Flood Hazard Area in Tangent



Source: [FEMA's National Flood Hazard Layer (NFHL) Viewer]

Smoke/Poor Air Quality

Events: 2020 fires caused smoke in the Willamette Valley.

Vulnerability and Impacts: Smoke can enter living spaces in older homes with degraded insulation or limited air filtration.

Volcano

Events: None.

Wildfire

Events: The September 2020 wildfires were the largest wildfire event in the county.

Vulnerability and Impacts: Tangent was impacted indirectly by smoke.

Winter Storm/Ice Storm

Events: Several winter storms and a notable ice storm in February 2021 (DR-4599) and January 2024 (DR-4768).

Vulnerability and Impacts: Trees were downed by these two storms as were power lines causing an electricity outage.

Windstorm/Tornado

Events: Strong wind events occur nearly annually in the Southern Willamette Valley.

Vulnerability and Impacts: Windstorms can down trees and power lines.

Mitigation Strategy

During the 2023-2024 Linn County and Tangent NHMP update process, the DLCD planner and Tangent representatives assessed the mitigation strategy actions within the 2017 Tangent Addendum. Together they revised and updated that list of actions to reflect the revised risk assessment for Tangent.

Table TG-5. Completed Actions - Tangent

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Priority #7	Flood	For locations with repetitive flooding and significant damage or road closures, determine and implement mitigation measures such as upsizing culverts or storm water drainage ditches.	Public Works	Long-Term	Complete	Storm water system improvements were made in priority areas.
Pool #5	Earthquake	Inventory critical infrastructure or facilities vulnerable to seismic risk and consider options for seismic retrofit.	Public Works, County	Long-Term	Complete	The DOGAMI report provides the inventory and vulnerability. The city supports the owners of at-risk properties to retrofit them.
Pool #6	Flood	Complete an inventory of locations in city of Tangent subject to frequent storm water flooding outside of designated floodplains	Public Works	Short-Term	Complete	All flooding areas are all mapped
Pool #7	Flood	Work with the railroad to replace the existing culvert at the intersection of the railway and Tangent Drive with a larger capacity culvert.	Public Works, Administration	Long-Term	Complete	

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Pool #9	Flood	Research potential stormwater management strategies along Tangent Drive and Birdfoot Lane, such as developing bioswales, to reduce flooding in these areas.	Public Works	Long-Term	Complete	Added four culverts under the road, could in the future make one large culvert if the road is reconstructed. Flooding not an issue between those two roads
Pool #11	Severe Weather (Winter Storm/ Windstorm)	Coordinate with the local utility to identify any power lines that could be placed underground to prevent power outages from wind and winter storms.	Public Works	Short-Term	Complete	Residents and city staff both call in concerns about trees to cable or power company. Tangent is a Tree City and is caring for street trees and trees on public property.

Table TG-6. Actions Removed from the Tangent Addendum

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Pool #2	Multi-Hazard	Develop a data collection system to track undeclared natural hazard events.	Public Works	Short-Term	Remove	
Pool #3	Drought	Update Water System Master Plan	Public Works	Short-Term	Remove	Not relevant, currently all residents are on private wells. Discussions have started to address the potential for creating a public water system.

Action Item	Hazard	Action Title	Coordinating Agencies	2017 Timeline	2024 Status	Notes
Pool #10	Flood	Encourage development of acquisition and management strategies to preserve open space for flood mitigation, fish habitat, and water quality in the floodplain and reduce risk to flood prone properties as well as preserve space for open space property.	Public Works	Long-Term	Remove	This action is not relevant to Tangent's development potential.
Priority #1	Multi-Hazard	Update Comprehensive Plan to reflect updated information regarding natural hazards	Planning, Administration	Short-Term	Remove	In Tangent the voters determine whether the city can initiate a change in the Comp Plan; lower priority. If state requires it, then city will update; ballot measure to remove that requirement.
Priority #3	Multi-Hazard	Provide NHMP awareness training to City staff to incorporate Natural Hazard Mitigation Planning aspects into their daily work.	Administration	Ongoing	Remove	When the city develops an Emergency Operations Plan, it will ensure that awareness training is included in the delivery of final products.
Priority #6	Earthquake	Encourage reduction of nonstructural and structural earthquake hazards in existing and future homes, schools, businesses, and government offices through public education.	Administration	Ongoing	Remove	With respect to structural seismic standards, this is addressed through the existing building code. Nonstructural elements can be addressed through public education materials.

Table TG-7. Ongoing, Short-, and Long-Term Projects – Tangent

*Short term 1-3 years, Medium term 3-5 years, Long term > 5 years

Hazard Action Item	Action Title	Coordinating Agencies	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 1	Continue current public education efforts and improve public outreach about the natural hazards Tangent is vulnerable to and mitigation measures residents can implement.	Administration	Tangent Fire	Ongoing	Retain, revised	City General Fund	The Tangent RFPD is investing in fire education. The city promotes the Great Shake Out. There are other public education efforts for Smoke/Poor Air Quality and Extreme Heat hazard that are supported by this action.
Multi-Hazard 2	Inform K-12 school children and their parents about vulnerability assessment and mitigation actions (like Go Bags, Emergency Plans and Shelter in Place supplies) to improve preparation.	Administration, County	Tangent Fire	Ongoing	Retain, revised	City General Fund	As written, this action is not the role of the city. Revised to refer to work the city and RFPD engage in that involves providing information to kids and their parents during events outside of the schools.
Multi-Hazard 3	Prepare residents to manage without power, utilities, or transportation during disaster event; communicate and promote readiness; build cooperative relationships with private businesses for assistance during disaster	Administration, Public Works	Tangent Fire	Ongoing	Retain	City General Fund	The Tangent RFD promotes sheltering in place; they promote Go Bags by informing the public what goes into them. The station used to be self-sufficient but had to decommission a fuel tank; now dependent on a company to supply fuel.

Hazard Action Item	Action Title	Coordinating Agencies	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Multi-Hazard 4	Create or update a Continuity of Operations Plan (COOP).	Administration, City Manager	Tangent Fire, Linn County	Short term; 1-3 years	Retain, revised	City General Fund	City intends to formalize a COOP draft protocol. As there are only two staff in the city, this may be a simple protocol to define. City staff would like to include an EOP process in this work. The Tangent RFDD and the county would be important partners in this work.
Drought 1	Support programs that promote measures to reduce water use during drought emergencies.	Public Works, County		Ongoing	Retain, revised	City General Fund	The city can provide information about how to reduce water use.
Flood 1	Ensure continued compliance in the National Flood Insurance Program (NFIP) through enforcement of the provisions of flood damage prevention in the Development Code.	Administration		Ongoing	Retain	City General Fund	City has recently communicated with FEMA about compliance with NFIP.
Flood 2	Build a demonstration rain garden on public property and provide rain garden "how to" in the form of booklets or signs around the demonstration site to get homeowners involved to help reduce runoff.	Public Works	Tangent Fire, Linn County; Tangent Together	Long term; >5 years	Retain	City General Fund	This could be integrated within the park around city hall. Perhaps Tangent Together could support or lead this action.

Hazard Action Item	Action Title	Coordinating Agencies	Partner Organizations	2024 Timeline*	2024 Status	Potential Funding Sources	Notes
Windstorm 1 and Winter Storm 1	Local citizens and city staff monitor the health of trees near power lines and notify cable and power companies of concerns. The city trims trees when fallen tree limbs require removal to prevent future power outages.	Public Works	Utility Providers	Ongoing	Retain, revised	City General Fund	More often than power lines becoming an issue, the cable lines were allowed to stretch, mostly outside the city.
Wildfire 1	Implement wildfire actions in the Linn County Community Wildfire Protection Plan as they relate to Tangent.	Administration	Tangent Fire	Ongoing	Retain	City General Fund	There is very low threat in the Tangent RFD area, however the city supports the district and other efforts aimed at fire control. Field burning no longer a concern due to changes in farm practice.

Plan Implementation and Maintenance

The City Council is responsible for adopting the Linn County MJ-NHMP including the City of Tangent addendum to the Linn County NHMP. The Tangent City Manager is responsible for coordinating implementation and maintenance of the Tangent Addendum to the Linn County MJ-NHMP and will participate in the Linn County NHMP implementation and maintenance meetings. The Tangent representative will report on city specific activities as appropriate and will keep the City Council informed of the implementation and maintenance work conducted on the Linn County MJ-NHMP over the course of the plan's five-year life. See Volume I, Section 4 for additional information.

Keeping the public informed of Tangent's efforts to reduce the risk from future natural hazards events is important for successful plan implementation and maintenance. Tangent is committed to involving the public in the plan implementation and maintenance process. See Volume I, Section 4 for more information.

The Linn County Multi-Jurisdictional Natural Hazards Mitigation Plan and city addenda will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, Tangent will also review and update its addendum. The Tangent Convener will be responsible for consulting elected officials and the public to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help Tangent's Convener determine what components of the mitigation plan need updating.

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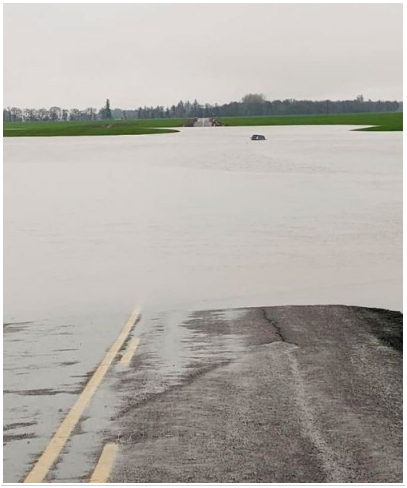

Linn County

MULTI-JURISDICTIONAL NATURAL HAZARDS MITIGATION PLAN

VOLUME III: APPENDICES

2025

VOLUME III: APPENDICES

TABLE OF CONTENTS

Appendix A: Planning and Public Process A-1
Appendix B: Community Profile B-1
Appendix C: Economic Analysis of Natural Hazard Mitigation Projects C-1
Appendix D: Grant Programs and Resources D-1
Appendix E: DOGAMI Multi-Hazard Risk Report for Linn County, Oregon E-1
Appendix F: OCCRI Future Climate Projections, Linn County, Oregon F-1
Appendix G: Resolutions, FEMA Plan Review Tool G-1

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APPENDIX A:
PLANNING AND PUBLIC PROCESS

TABLE OF CONTENTS

Project Background A-1
Plan Update Changes A-1
Update Public Participation Process A-3
Public Involvement Summary A-4
Linn County Steering Committee A-9
NHMP Survey Results A-32

LIST OF TABLES

Table A-1. Changes to Plan Organization A-2

LIST OF FIGURES

Figure A-1. Linn County Webpage – August 2024 and December 2024/January 2025 ..... A-4
Figure A-2. Linn County Tabling Event A-5
Figure A-3. City of Gates Webpage with Links to Survey and Information A-6
Figure A-4. City of Lyons Webpage with Links to Information and Survey, and Notices A-7
Figure A-5. Lyons RFD Webpage with Link to Survey A-7
Figure A-6. Steering Committee Meeting #1 June 30, 2022 - Agenda A-10
Figure A-7. Steering Committee Meeting #1 June 30, 2022 - Notes A-11
Figure A-8. Steering Committee Meeting #2 November 21, 2023 - Agenda A-12
Figure A-9. Steering Committee Meeting #2 November 21, 2023 –Notes A-13
Figure A-10. Steering Committee Meeting #3 February 7, 2024 – Agenda A-16
Figure A-11. Steering Committee Meeting #3 February 7, 2024 - Notes A-17
Figure A-12. Steering Committee Meeting #4 March 13, 2023 - Agenda A-21
Figure A-13. Steering Committee Meeting #4 March 13, 2024 - Notes A-22
Figure A-14. Steering Committee Meeting #5 April 3, 2024 - Agenda A-24
Figure A-15. Steering Committee Meeting #5 April 3, 2024 - Notes A-25
Figure A-16. Steering Committee Meeting #6 July 17, 2024 – Agenda A-27
Figure A-17. Steering Committee Meeting #6 July 17, 2024 – Notes A-28
Figure A-18. Steering Committee Meeting #7 October 23, 2024 – Agenda A-29
Figure A-19. Steering Committee Meeting #7 October 23, 2024 - Notes A-30

This appendix provides an overview of the plan update process, including a summary of major changes made to the MJ-NHMP. It also summarizes the Steering Committee's role and public outreach conducted by the county and participating jurisdictions, including a summary of input gained through the community survey.

Project Background

Linn County staff and staff from the participating incorporated cities and special district within it partnered with staff members of the Oregon Department of Land Conservation and Development (DLCD) to update the 2025 Linn County Multi-Jurisdictional Natural Hazards Mitigation Plans (NHMP, MJ-NHMP). The Disaster Mitigation Act of 2000 requires communities to update their mitigation plans every five years to remain eligible for Hazard Mitigation Grant funding.

DLCD staff worked with the Linn County Planning Manager and the Linn County Emergency Manager to form the Linn County NHMP Steering Committee to represent the whole community. The Steering Committee included representatives from the cities of Gates, Halsey, Harrisburg, Lebanon, Lyons, Millersburg, Scio, Sodaville, Sweet Home, and Tangent, and the Lyons Rural Fire District. See the Plan's acknowledgements page for the list of participants.

This MJ-NHMP update includes several new jurisdictions. The city of Millersburg joined the Linn County MJ-NHMP for the first time and the City of Sweet Home incorporated its stand-alone plan into an Addendum to the multi-jurisdictional plan. The City of Gates is divided by the Marion/Linn County border. Gates joined the Linn County planning process having previously been a participant in the Marion County plan, and city staff lacked the capacity to join the Marion County plan update due to recovery efforts underway at that time from the Beachie Creek fire. The City of Brownsville declined to join the plan during this update and the City of Waterloo declined to update their existing Addendum due to staff capacity issues. The Lyons Rural Fire Protection District joined the multi-jurisdictional process to update their stand-alone plan ahead of schedule. The DLCD project managers drafted the plan and addenda in conjunction with the representatives from the county, cities, and district. The Steering Committee made several changes to the 2017 Linn County MJ-NHMP as described below.

Plan Update Changes

Table A-1, below, notes *major* changes made to the MJ-NHMP during the 2023-2025 plan update process. Major changes include the replacement or deletion of large portions of text to provide the most recent data and information, changes to the organization of the Addenda, new mitigation action items, and updates to existing mitigation actions. If a section is not addressed in this appendix, then it can be assumed that only minor changes were made.

The 2025 Linn County Multi-Jurisdictional Natural Hazard Mitigation Plan retains the same format and basic organization as the 2017 MJ-NHMP prepared by the Oregon Partnership for Disaster Resilience.

Table A-1. Changes to Plan Organization

2017 Linn County Multi-Jurisdictional NHMP	2025 Linn County Multi-Jurisdictional NHMP
Front Page	Updated to include photos, the effective dates of the plan, and a location map.
Acknowledgements	Updated with 2023-2025 participants
Approval Letter and Resolutions	The final FEMA approval letter is after the Acknowledgements. The accompanying Plan Review Tool and the locally adopted resolutions are provided in Appendix G.
FEMA Review Tool	Same as above
Table of Contents	Updated
Volume I: Basic Plan	
Executive Summary	Included an executive summary that can also serve as a stand-alone document for educational and outreach purposes.
Section 1: Introduction	
Section 2: Risk Assessment	Incorporated multi-hazard risk report prepared by Oregon Department of Geology and Mineral Industries using HAZUS analysis and depth grids for flood exposure analysis. Incorporated Future Climate Projections Report for Benton County prepared by Oregon Climate Change Research Institute to address impacts to hazard frequency and characteristics from warming temperatures. Added consideration of Extreme Temperatures, Dam Failure, and Poor Air Quality as a related effect of Wildfires to the characterization of the hazards faced in Linn County.
Section 3: Mitigation Strategy	Updated mitigation strategy actions and added new.
Section 4: Plan Implementation and Maintenance	Provided links to county plan documents and updated plan maintenance schedule.
Volume II: City Addenda	
Gates	Updated infrastructure, critical facilities, recent hazard events, and mitigation strategies
Halsey	Updated infrastructure, critical facilities, recent hazard events, and mitigation strategies
Harrisburg	Updated infrastructure, critical facilities, recent hazard events, and mitigation strategies
Lebanon	Updated infrastructure, critical facilities, recent hazard events, and mitigation strategies
Lyons	Updated infrastructure, critical facilities, recent hazard events, and mitigation strategies
Lyons Rural Fire District	Revised stand-alone plan to create a new Addendum to the Linn County MJ-NHMP
Millersburg	Developed new Addendum
Scio	Updated infrastructure, critical facilities, recent hazard events, and mitigation strategies
Sodaville	Updated infrastructure, critical facilities, recent hazard events, and mitigation

2017 Linn County Multi-Jurisdictional NHMP	2025 Linn County Multi-Jurisdictional NHMP
	strategies
Sweet Home	Revised stand-alone plan to create a new Addendum to the Linn County MJ-NHMP
Tangent	Updated infrastructure, critical facilities, recent hazard events, and mitigation strategies
Volume IV: Appendices	
Appendix A: Planning and Public Process	Provided updated documentation of the planning and public process for 2023-2025.
Appendix B: Community Profile	Updated demographic information and other details about the county and jurisdictions.
Appendix C: Economic Analysis of Natural Hazard Mitigation Projects	No change.
Appendix D: Grant Programs	Updated grant program list and links
	NEW Appendix E: DOGAMI Multi-Hazard Risk Report for Linn County
	NEW Appendix F: OCCRI Future Climate Projections for Linn County Report
	NEW Appendix G: Approval letters, Review Tool, and Resolutions

Update Public Participation Process

Linn County is dedicated to directly involving the public in the review and update of the Multi-Jurisdictional Natural Hazards Mitigation Plan. The Steering Committee developed an outreach strategy to provide opportunities for the public to provide input and feedback during the plan update process. Linn County staff spearheaded the outreach effort by creating an NHMP update webpage. This webpage included background information on the NHMP, Steering Committee meeting documentation, a link to the countywide survey which informed the risk assessment and mitigation strategy, open from August 5, 2024, through October 31, 2024 (summarized below), and the public review draft of the mitigation strategy.

The cities and special district included a link to the County webpage on their respective webpages, among other outreach strategies further described below and in each jurisdiction's addendum. The Plan's executive summary was also used in a modified format during outreach to provide a snapshot of the hazards in Linn County and the plan update process and can serve as a stand-alone outreach tool during the Plan's implementation period. Information about the Steering Committee, including meeting agendas and notes, is also included in this section.

A public comment period on the draft mitigation strategy was held from December 16, 2024, through January 15, 2025, including direct outreach to neighboring jurisdictions by Linn County staff. No public comments were received on the mitigation strategy.

Public Involvement Summary

In addition to providing information on their webpages, the county and jurisdictions used a variety of other methods to spread the word about the plan update and the NHMP survey, including tabling at community events, posting flyers in public buildings, and sharing opportunities for feedback via newsletters, social media, and other means. The following figures provide examples of the outreach conducted.

Figure A-1. Linn County Webpage – August 2024 and December 2024/January 2025

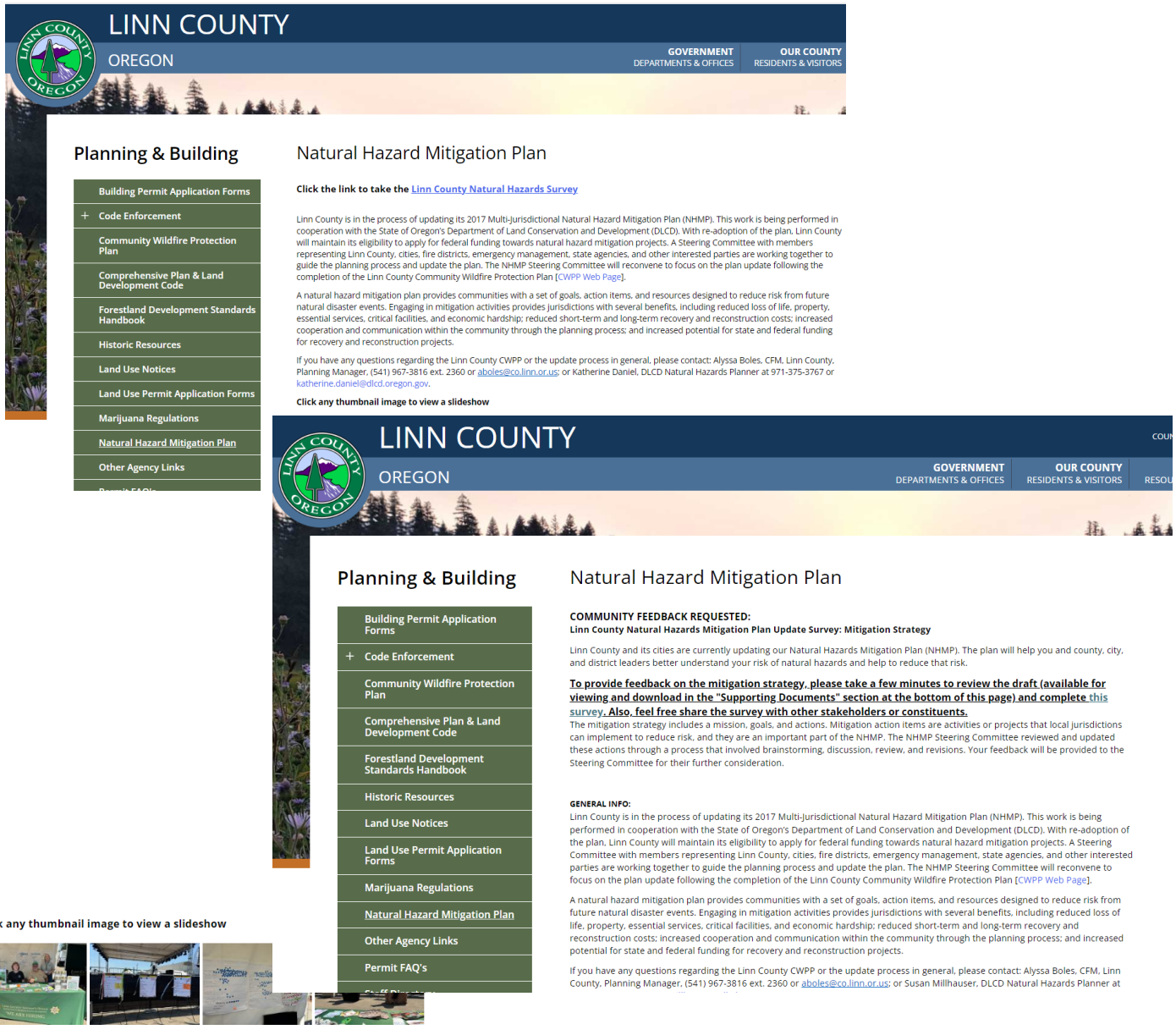


Figure A-2. Linn County Tabling Event

Figure A-3. City of Gates Webpage with Links to Survey and Information

Figure A-4. City of Lyons Webpage with Links to Information and Survey, and Notices

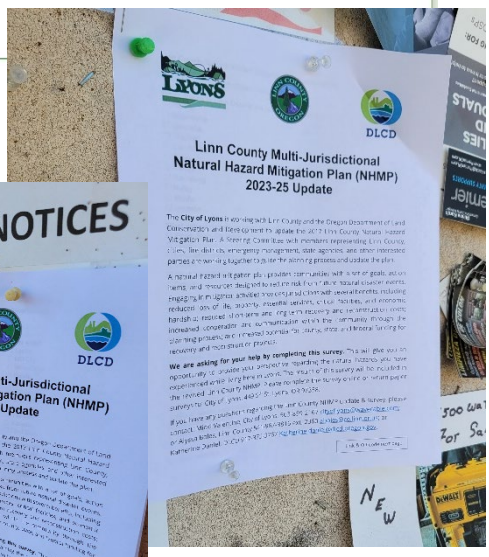
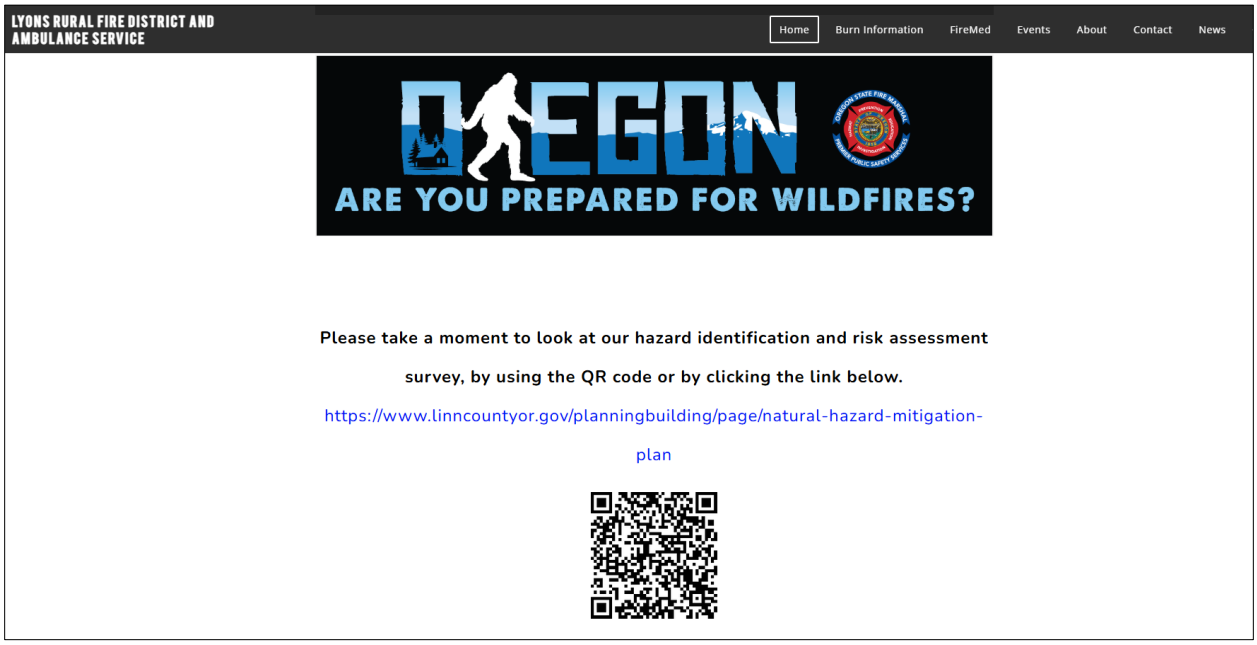


Figure A-5. Lyons RFD Webpage with Link to Survey



Linn County Steering Committee

The Linn County MJ-NHMP Steering Committee members were familiar with Linn County and local communities and how the people and assets may be affected by natural hazard events. The Steering Committee was comprised of members and interested parties. The members represented the county, cities, and the district that are plan holders. The interested parties represented a neighboring community, a local fire district, an academic institution with facilities in the Linn County, and an electric utility provider serving the county. See the acknowledgements page for a list of participants.

The Steering Committee formally met seven times in 2023 and 2024 to discuss and revise the Plan, during which DLCD staff guided members through the update process. The planning process included hazard identification and risk assessment, confirmation of mitigation goals and objectives, review of action items, and development of methods for information sharing to engage public participation. Steering Committee members contributed data and maps, and reviewed and updated the community profile, risk assessment, action items, and implementation and maintenance plan. Steering Committee agendas and meetings notes are included below.

The DLCD project manager also met with individual Steering Committee members to discuss updates to their city and special district addendum. Jurisdictions met internally as well to gather feedback from other members of their staff and from elected and appointed officials, further described in each addendum.

Figure A-6. Steering Committee Meeting #1 June 30, 2022 - Agenda

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan
2022 Update Kickoff Meeting AGENDA

OREGON
Department of Land Conservation & Development

Thursday, June 30, 2022
2:00 PM– 3:00 PM
Online via Zoom
https://us02web.zoom.us/j/84548634469?pwd=4YntgC71KmbYFq-TzZdfREHsR4r_xb.1

Welcome/Introductions	**2:00 pm**
• Please share your name, title, and jurisdiction.	Alyssa Boles, Planning Director
NHMP Project Overview	**2:10 pm**
• IGA/ Scope of Work • Timeline • Steering Committee • Public Engagement	Pamela Reber, DLCD Alyssa Boles, Planning Director
OCCRI Future Conditions Report Introduction	**2:20 pm**
• Report purpose/metrics used • Any specific local needs for the climate report?	Meghan Dalton, OSU OCCRI
Committee Discussion	**2:40 pm**
• What do you want to get out of this plan update (as a jurisdiction)? What needs or expectations? • What are some ideas for public engagement strategies? • What timeline would be necessary for all jurisdictions to approve the IGA with their councils/boards?	All – Roundtable response Alyssa Boles, Planning Director
Next Steps	**2:55 pm**
• Cities take IGA to Councils for approval. • Participants submit cost share monthly/quarterly	All

Linn County MJ NHMP Website:

Forthcoming following County Website Update

Figure A-7. Steering Committee Meeting #1 June 30, 2022 - Notes

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan

2022 Update Kickoff Meeting

Thursday, June 30, 2022
2:00 PM– 3:00 PM
Online via Zoom

Meeting Notes

Attendees included:[1]

Steering Committee:
Pam Reber, DLCD
Alyssa Boles, Linn County
Kate Bentz, Linn County
Emerson Marsh, Linn County Sheriff's Office
Ric Lentz, Linn County Sheriff's Office

Partners:
Meghan Dalton, OSU OCCRI

Welcome/Introductions
Pam Reber asked attendees to put their names and titles in the chat to facilitate efficiency. She introduced herself and then summarized the attendance at this kickoff meeting.

NHMP Project Overview
Pam described the contents of and reason for jurisdictions to sign an IGA with DLCD to update the NHMP. She presented a draft timeline and described the work of the Steering Committee. The importance of and county responsibility for outreach was also discussed.

OCCRI Future Conditions Report Introduction
Meghan Dalton of the Oregon Climate Change Institute presented a description of the nature of the institute's purpose for the Future Climate Projections reports they have produced for many Oregon counties and what metrics they use to project the impact of a changing climate on natural hazards. She asked if there were any specific needs that the committee wanted to identify for this report.

Committee Discussion
The discussion touched on the topics of the impact of early snow melt in the spring and later dryness during the summer season. Also mentioned was the Army Corps of Engineers drawing down the dam pools and the recreational use of Foster Reservoir. Logging and the impact of wildfire were noted during the discussion of changes in the climate as they impact natural hazards. Flooding was noted as an occasional issue and the information provided by Meghan Dalton regarding the projections for increased wet day events caused a question about the potential impact of that future climate condition on flooding occurrences.

Next Steps
The representatives of cities were urged to review the IGA's and have them signed by decision makers as appropriate.

[1] A full attendance list was not located.

Figure A-8. Steering Committee Meeting #2 November 21, 2023 - Agenda

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan Update

AGENDA

Tuesday, November 21, 2023
1:00 PM– 2:30 PM
Basement Meeting Room, Linn County Courthouse
300 Fourth Avenue SW, Albany, Oregon

Welcome and Introductions (Alyssa Boles, Linn County Planning Director — 10 minutes
Updates on the CWPP process (Kate Bentz, Linn County Planner) — 10 minutes

NHMP project overview (Katherine Daniel, DLCD Planner) — 15 minutes
- What entities can be plan holders? What is the result of the process?
- What are the tasks in the NHMP update process?
- Why does your jurisdiction or district want to participate in the NHMP update?

Steering Committee — 15 minutes
- Who will do what? Scope of Work review, IGAs.
- What will the schedule be? Discussion.
- How will we make decisions? Discussion.

Interested parties and partners — 10 minutes
What entities are missing from a whole community approach? How will we give them an opportunity to participate in the process?

How will we operate? — 15 minutes
- In person, online, or hybrid?
- Publicly noticed? Room for public input at certain points?
- Meeting Notes: *Thank you, Kate.*

Key features of an efficient update process *(FEMA Review Tool overview)* — 20 minutes
- Focused rather than broad, mitigation strategy for each hazard identified by each juris.
- Scientific basis of fact to support mitigation strategy.
- Public engagement – County web page? Survey? In person events like Preparedness Fairs
- Communicating - Using Box, preparing to provide comments when drafts are ready for steering committee review and that of interested parties as well.

Next Steps *(homework Read the plan, Kate Notes, Katherine IGAs and Box* — to end of meeting

Figure A-9. Steering Committee Meeting #2 November 21, 2023 –Notes

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan Update

Tuesday, November 21, 2023
1:00 PM– 2:30 PM
Basement Meeting Room, Linn County Courthouse
300 Fourth Avenue SW, Albany, Oregon

Meeting Notes

Welcome and Introductions (Alyssa Boles, Linn County Planning Director) 10 minutes

Katherine Daniel – DLCD
Kate Bentz – Linn County Planning
Alyssa Boles – Linn County Planning
Matt Straite – City of Millersburg
Shane Wooton – Albany Fire Department and Linn Co Fire Defense Board
Erik Anderson – Linn County Public Health
Kevin Hamilton – Linn County Road Department
Ric Lentz – Linn County Emergency Management
Emerson Marsh - Linn County Emergency Management
Michelle Eldgridge – City of Harrisburg
Scott McDowell – City of Brownsville
Elizabeth Coleman – City of Brownsville
Daineal Malone – Linn County Road Department

Updates on the CWPP process (Kate Bentz, Linn County Associate Planner)

The County has held steering committee meetings, a city input meeting, a community group input meeting, a meeting with the County Fire Defense Board. Currently working on risk assessment and got the final major data source for risk assessment, which was used in conjunction with fire district input to identify specific mapping points. The County is working with local partners to update action items, and also working on finalizing a draft plan and action items. The draft plan will be distributed to all partners who have engaged. There is a public input meeting scheduled in December for all county residents to attend. Cities are encouraged to engage their local citizens to attend. After that meeting, final approval from the required groups (Board of Commissioners, ODF, LCFDB) is needed, along with final Board adoption.

NHMP project overview (Katherine Daniel, DLCD Planner)

- What entities can be plan holders? What is the result of the process?
- What are the tasks in the NHMP update process?
- Why does your jurisdiction or district want to participate in the NHMP update?

The NHMP is intended to serve plan holders – cities, counties, and special districts.
Steering committee is comprised of the County and cities within Linn County. Task list for

the update can be found in the IGA. Cost share - FEMA provides 75% of cost, with 25% local match. (OEM had additional funding to cover cost share, so tracking participant hours should not be necessary. Katherine Daniel is confirming with OEM that this is still the case.). Plan holders will be expected to provide data and information for the plan, particularly for the local mitigation strategies. Looking for engagement with interested parties (council members, commissioners, etc. within each jurisdiction). Public engagement program – FEMA wants to know that public participation is provided with a wide range of perspectives. Will need the committee to review the draft plan update and provide input and feedback. County and cities will be obligated to adopt the Plan once FEMA indicates it's approvable. DLCD is going to organize, lead, and manage the plan supported by Linn County staff. It is important to have an NHMP to qualify for FEMA grant funding, along with identifying ways to support community resilience.

Steering Committee

- Who will do what? Scope of Work review, IGAs.
- What will the schedule be? Discussion.
- How will we make decisions? Discussion.

There will be 5-7 meetings over the course of the year. Some small group meetings, plus some larger meetings, some county specific. Spend some time supporting public engagement process – free public events for outreach, social media, public surveys. Review drafts prepared by DLCD. Keep elected officials aware of what's going on in the process and up to adoption.

Katherine Daniel will develop a schedule. **Assign some homework – all plan holders should review the current Natural Hazard Mitigation Plan, especially their city addendum**. The current city addenda can be accessed on Box: https://dlcd.box.com/s/19w9yi7io9zmxdmr8gfu8iy02ofbl9ov. The main plan can be accessed on the County Website: https://www.linncountyor.gov/planningbuilding/page/natural-hazard-mitigation-plan.

The IGA talks about cost share, but Katherine doesn't want cities to sign if cost share doesn't need to be done. DLCD will redraft the IGA with applicable tasks. The committee will look at ways to serve underrepresented people (based on an EO from the US President to FEMA). The committee will assess risks of other hazards (including fire, but that is primarily covered as part of the CWPP). DOGAMI is contracted to prepare a multi-hazard risk assessment for DLCD. OCCRI report for climate change projections will be considered as well. Risk can also be assessed based on community experience (winter storms, ice storms, wind storms – engagement from partners can help with this). Will then move into mitigation strategy and plan maintenance. Don't want the plan to be a "shelfie." More opportunity for public engagement to follow on the full document.

Showed the CWPP/NHMP update schedule (found in the Box). Will be working through the end of 2024, schedule is flexible and not set in stone. Suggestion was a doodle poll – meetings possibly 1st or 3rd week of each month preferred, later in the week. Possibly have meeting set up as hybrid meeting in considering small city travel times.

Steering committee is composed of plan holders. Steering Committee will make decisions. Will listen to parties and partners, but decision is ultimately up to the steering committee. Preference is to reach agreement on updates on a consensus basis.

Interested parties and partners

What entities are missing from a whole community approach? How will we give them an opportunity to participate in the process?

Interested parties include neighboring communities, local and regional agencies, agencies that regulate development., business, academia and other non-profit, utilities, watershed councils, school districts, hospitals, homeless advocacy groups. The option is available to invite the public to committee meetings or have an input section on the agenda on some of the meetings. Maybe have public input meetings at certain points – when feedback is needed on risk assessment – maybe 3rd meeting and 6th meeting, but not all meetings.

How will we operate?

- In person, online, or hybrid? - *Katherine Daniel commits to setting up Steering Committee meetings for hybrid participation.*
- Publicly noticed? Room for public input at certain points?
- Meeting Notes: *Thank you, Alyssa.*

Key features of an efficient update process *(FEMA Review Tool overview)*

- Focused rather than broad, mitigation strategy for each hazard identified by each juris.
- Scientific basis of fact to support mitigation strategy.
- Public engagement – County web page? Survey? In person events like Preparedness Fairs
- Communicating - Using Box, preparing to provide comments when drafts are ready for steering committee review and that of interested parties as well.

Be focused rather than broad, think locally. Hopefully, the committee can focus on things that are really important to get done and cost dollars to do. Specific actions can be better implemented. An efficient update should have a scientific basis in fact. Spend some time understanding the DOGAMI report – does it help us become more focused? OCCRI – change in climate acting as an amplifier – fires, weather patterns (wind/ice storms) are changing as a result. Public engagement – key to getting approval by FEMA – make sure vulnerable people and underserved people have the ability to participate. Will use Box for NHMP data share, exchange, edit/update, central location, and communication. Katherine will provide a Box tutorial.

Next Steps *(homework Read the plan, Kate Notes, Katherine IGAs and Box*

Katherine will follow up with an email after the meeting.

Figure A-10. Steering Committee Meeting #3 February 7, 2024 – Agenda

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan Update

AGENDA

Wednesday, February 7, 2024
1:00 PM– 2:30 PM
In person at the OSU Extension Office
33630 McFarland Rd, Tangent
and online
via Microsoft Teams meeting
Join on your computer, mobile app or room device
Click here to join the meeting
Meeting ID: 246 787 193 33
Passcode: nhsc8w

Welcome and Introductions (Alyssa Boles, Linn County Planning Director)	10 minutes
Review and adopt notes from 11/21/23 (Alyssa Boles)	5 minutes
Updates on the CWPP process (Kate Bentz, Linn County Planner)	10 minutes
NHMP project updates (Katherine Daniel, DLCD Planner) • Cost Share and IGA's • Scope of Work review • Proposed Schedule • Thoughts about how to improve on 2017 plan	15 minutes
Risk Assessment • Methods and data for risk assessment (Katherine) • Hazards of highest concern (All) • Rank historical prevalence (activity for all participants) • Critical Facilities; evaluate list and prepare for DOGAMI analysis (Katherine)	30 minutes
Using Box • Demonstration (Katherine) • Practice: edit roster list (All) • Assignment: update critical facilities list; set due date target with group.	15 minutes

Next Steps: *Homework Update Critical Facilities Lists*
Next Meeting: *March 6, 2024, 1-2:30 pm hybrid meeting*

Figure A-11. Steering Committee Meeting #3 February 7, 2024 - Notes

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan

Meeting Notes

February 7, 2024
1:00 PM – 2:30 PM
In person at the OSU Extension Office
33630 McFarland Rd, Tangent
and online

Attendees:

- Kate Bentz, Associate Planner, Linn County
- Julia Fox, Assistant Planner, Linn County
- Alyssa Boles, Planning Manager, Linn County
- Ric Lentz, Emergency Manager, Linn County
- Emerson Marsh, Emergency Management, Linn County (virtual)
- Kevin Hamilton, Road Department Operations Manager, Linn County (virtual)
- Daineal Malone, Road Department Engineer, Linn County Road Department (virtual)
- Jeff Carlson, Consumers Power Inc
- Jerry Lachenbruch, Mayor – City of Halsey
- Micki Valentine – City of Lyons (virtual)
- Ron Whitlach — City of Lebanon (virtual)
- Kelly Hart – City of Lebanon (virtual)
- Kevin Kreitman – City of Millersburg (virtual)
- Alex McHaddad – City of Sodaville (virtual)
- Traci Archer – City of Gates (virtual)
- Matt Straite – City of Millersburg (virtual)
- Michelle Eldridge – City of Harrisburg
- Ginger Allen – City of Scio
- Elizabeth Coleman – City of Brownsville (virtual)

Welcome and Introduction (Alyssa Boles, Linn County Planning Director)

Review and adopt notes from 11/21/23

- Members present voted to adopt minutes

Updates on the CWPP (Kate Bentz, Linn County Planner)

- CWPP is 99% done, pending final edits and will be sent to the Board of Commissioners, Oregon Dept. of Forestry, Fire Defense Board for final approval

- Katherine Daniels- CWPP feeds into the NHMP, Stormwater Plans, Emergency Operation Plans, etc. are all connected within the NHMP w/ the intention to highlight mitigation strategies

NHMP Project cost updates (Katherine Daniel, DLCD Planner)

- What is required of participants? – Participate in 5-7 meetings, spend time soliciting public input on the plan (ask yourself- what ways do you think would be most effective ways to get feedback from members of your community on the plan?), keep your elected officials informed of what is happening during the update process so they are prepared to adopt the plan.
- What is happening today- looking at the schedule & scope of work so that everyone is aware of what they are prepared to do.
- Intergovernmental Agreement (IGA) Updates
    - Cost Share- cost sharing with local jurisdictions is no longer required for FEMA grant reporting, those costs have been covered by the State of Oregon! IGAs are revised to reflect the changes. IGAs contain yellow highlights on places where the language has been changed, those highlights can be removed when you bring the IGA for adoption by your elected officials.
    - An extension for the Period of Performance has been applied for to FEMA/OEM and will be reflected in the IGA agreement.
    - Millersburg, Brownsville, and Gates will receive revised IGAs to reflect the fact that these are the first NHMPs for their jurisdiction.
    - Task for cities- take the IGA to your elected officials and bring them back to Katherine signed, suggested deadline by April.
- Overview of the scope of work
    - We are in the organizing stage and still reaching out to interested parties. (Notes- open to other parties joining us, reach back out to Erik Anderson from LCPH).
    - The next stage will be reviewing and updating the plan through re-doing the risk assessment, devising mitigation strategies for your community, and documenting how you are involving members of the public in the process through public outreach events.
    - The last stage of the plan is the Review & Approval portion which is done by OEM and FEMA to ensure that the NHMP covers all the requirements.
- Schedule
    - We plan to meet 3 times in a row, February – April. March's meeting has been pushed back one week to March 13, 2024. March's meeting will include a presentation from the director of OCCRI who will be sharing on future climate projections from Linn County that will be incorporated into the risk assessment (available on Box). April meeting we will have a presentation from Matt Williams from DOGAMI, who will share the countywide evaluation of potential exposure and loss from potential hazards. There will be specific evaluation of threats to critical facilities.
    - Katherine will be working on drafting portions of the NHMP in the summer and the Risk Assessment will be available for public feedback in September, results from that should be available by October
    - One meeting in July will focus on the group overviewing mitigation strategy development, then individual meetings will be scheduled with each jurisdiction to go over mitigation strategies.

- The majority of 2025 will focus on OEM/FEMA review and local adoption.

- There was a question about the accuracy of the dates for Task #7 in the IGA. Katherine will be looking over all the individual IGAs to ensure that the dates in the scope of work are up-to-date.
- Each city has an individual addendum in the plan that will be updated or created as part of the update process, which is separate from the larger NHMP main document.

Soliciting feedback on how to improve from the 2017 plan (Katherine)

- Katherine and NHMP project team will be working WITH cities to review and update the addenda
- Suggestion to bring ODOT & Army Corps of Engineers to the table to work on mitigation actions with cities- we will look into involving other levels of jurisdiction on a case-by-case basis.

NHMP Risk assessment (Katherine)

- The Risk Assessment will include multiple parallel methods to paint a fuller picture which will include methods like:
  - DOGAMI hazard mapping, for hazards that are mapable like flooding, wildfire, landslides
  - OCCRI will provide climate projects which will impact the hazards in the plan
  - Local experience and knowledge through a tool developed by OEM-FEMA ("OEM-FEMA Methodology)
  - Public opinion- what do people perceive/believe are the greatest risks
- OEM-FEMA methodology- not a scientific measure, based on people's experiences and backgrounds using 4 scoring factors: History, Probability, Vulnerability, and Maximum Threat
- We will use a modified method to compliment the evaluation done in 2017

Steering Committee's Evaluation of Hazards in Linn County

- Frequency of hazards- What has happened in the past 5 years?
  - Winter storms (Harrisburg, countywide) in 2021, 2022, and 2023
  - Frequent "low level flooding" in Scio in approximately 7 out of the last 10 years, heavy rain on frozen ground causes flooding in people's homes- occurred during last ice storm. (Scio- bringing ODOT to table around peripheral issues, clearing out ditches/drainage facilities for mitigation action in Scio)
  - Heat waves / red flag conditions / high heat waves and smoke conditions- not necessarily linked to wildfire. Public power safety shutoffs activate emergency response. High heat events trigger cooling shelters and other risks to people/workers/infrastructure.
  - Sodaville has annual droughts, exacerbated this year by dam drawdowns. Other recent impacts from 2024 ice storm, and wildfire just outside the town in the summer of 2023.

- In general, what kinds of natural hazards happen in Linn County that warrant a strategy to reduce their impact? (Many discussed and listed below)
  - **Wildfire**

- **Flooding**
- **Winter storms** and **ice storms**- these are very different in terms of response; however we should dive more into how those things are mitigated. Consensus is to keep these as separate categories of hazard for now.
- Earthquakes- separated in EOP and NHMP, consensus to keep separate the potential **Cascadia earthquake** and smaller **"crustal" earthquakes**.
- **Avalanche**- experienced on HWY 20 going towards Hoodoo in recent years. Similar to **landslide**, unpredictable and blocks roads. What can be done to mitigate these? Consensus is to combine avalanches and landslides together under one hazard.
- **Extreme heat events** (+drought + smoke/bad air quality)- There's been an increase in extreme hot days that have been harmful to vulnerable populations which are also coinciding with power safety shutoffs (elderly, outdoor workers, medically fragile people, unhoused people).
- **Smoke/air quality**- caused from wildfire, industrial activity, drought / stagnation
- **Dam failure**- includes state owned dams as a FEMA requirement
- **Windstorm/tornado**- not exceedingly common but has occurred in the region in past years. Strong dry winds contributed to major wildfire spread in 2020.
- **Volcanic activity**- uncommon but a potential problem to parts of the County, particularly eastern parts.

Next steps:

- Continue Steering Committee Risk Assessment evaluation
- Collect list of critical facilities from jurisdictions for upcoming DOGAMI assessment
- Presentation from Erica Fleishman from OCCRI at next meeting

Figure A-12. Steering Committee Meeting #4 March 13, 2023 - Agenda

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan Update

AGENDA

Wednesday, March 13, 2024
1:00 PM– 2:30 PM
In person at the OSU Extension Office
33630 McFarland Rd, Tangent
and online
via Microsoft Teams meeting
Join on your computer, mobile app or room device
Click here to join the meeting
Meeting ID: 246 787 193 33
Passcode: nhsc8w

Welcome and Introductions	5 minutes
Review and adopt notes from 2/7/24	5 minutes
Update on the CWPP and IGA reminder	5 minutes
Tour of Box	10 minutes
Risk Assessment	50 minutes

- OEM-FEMA Methodology Review
- Review of hazards to be addressed in NHMP update
- **Future Climate Projections Report overview:** Presentation by Erica Fleishman, Director of the Oregon Climate Change Research Institute at Oregon State University, and questions. (20-25 minutes)

Discussion: How does this information inform our assessment of Probability for each of the hazards?

- Historical Assessment
- Probability Assessment

Next meeting: Vulnerability (Critical and Essential Facilities Lists) and Maximum Threat

Next Meeting: *April 3, 2024, 1-2:30 pm hybrid meeting*
Matt Williams, Geohazard Analyst for DOGAMI presenting Multi-hazard Risk Report

Figure A-13. Steering Committee Meeting #4 March 13, 2024 - Notes

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan

Meeting Notes

Wednesday March 13, 2024 | 1:00 PM– 2:30 PM
Meeting Room, Linn County Extension Office
33630 McFarland Rd, Tangent, OR

Attendees: Katherine Daniel, Alyssa Boles, Kate Bentz, Julia Fox, Ric Lentz, Emerson Marsh, Ginger Allen, Kelly Hart, Kevin Hamilton, Jason Rush, Joe Samaniego, Erica Fleishman, Ron Whitlatch, Stacie Cook, Micki Valentine, Briana Parra, Michele Eldridge, Matt Straite, Alex McHaddad

Review and Adopt 2/7/24 meeting notes: There were no corrections or additions suggested to these notes. Ric Lentz affirmed the notes without additions or corrections.

Updates on CWPP and IGAs: Emerson Marsh gave updates. The CWPP was approved by the fire board and awaiting approval from the board of commissioners, then it will go to the state and FEMA for final approval. IGAs are to be signed and approved by end of April. Katherine announced she had received some completed IGAs but not from every participating community.

Tour of Box: A virtual tour of Box was given, which provides a file sharing web base for all participating parties in Linn County's NHMP updating process. Katherine called for participating cities to contribute images of actual natural hazard or disaster events that have happened in their communities into Box.

Risk Assessment: Katherine Daniel went over the multiple ways communities can assess risk:

1. **OEM FEMA Methodology (Probability Rubric):** Katherine explained this exercise, which is calculated with four factors: History, Vulnerability, Probability, and Threat. The exercise began with an overview of extreme weather and natural disaster events in Linn County since 2017. The group was asked to submit a survey response to the most to least frequent extreme weather/natural hazard events in Linn County in the last 100 years, and then predictions for the future probability of these events. Katherine said she would take the submitted responses and turn them into a graphic representation for the group. The survey results will go into creating the probability rubric for Linn County.
2. **OCCRI Future Climate Projections:** Erica Fleishman from the Oregon Climate Change Research Institute presented this approach. Frequency and severity of many natural hazards is increasing. There are multiple predicted scenarios for what climate change is going to do, and precise projections get especially harder at local or regional levels. OCCRI is currently researching climate change projections and how they connect with population trends. They are looking at high-risk groups, such as old, young, pregnant people, those with preexisting conditions, and those living in poverty. Some climate and weather trends are harder to predict than others. Temperatures are predicted to continue to rise globally to the end of the century, even if emissions are cut. Almost all climate models are predicting more days with extreme heat globally. Cold extremes will

be less frequent, but more extreme. Intensity of extreme precipitation will increase, but overall there will be a decrease in annual rainfall. Mountain precipitation changes will exacerbate flooding, and more flooding earlier in the year. Higher frequencies of low summer soil moisture, i.e. drought. Projected trends in Linn County are expected to transition from snowfall to rainfall in the mountains in the cold season, and higher summer temperatures, particularly in June, July, and August. Higher droughts will lead to increased wildfire frequencies. Increase in the average number of days per year in which fire danger is very high. Increased wildfires will lead to reduced air quality. Total number of days in which it is smoky outside will not increase significantly in the coming decades, but the severity of the air quality on smoky days will increase. Droughts may cause the continued loss of wetlands. Climate change is predicted to lead to the expansion of some non-native species.

Alex McHaddad from the City of Sodaville asked if there were any predictions for what droughts will do to aquifers in the Willamette Valley. Erica answered that there was not OCCRI research into groundwater predictions, but pointed to current trends in California agricultural practices.

Kate Bentz from Linn County Planning and Building asked about specific invasive species predictions. Scotch broom is highly flammable and contributes to wildfires, and is predicted to be impacted by Climate Change. Erica answered that the plant is predicted to do well as snow and frost levels decrease.

Next Steps: DOGAMI Multi-Hazard Risk Assessment - Matt Williams, Geohazard Analyst will present this risk assessment conducted using modeled exposure and loss estimates.

Figure A-14. Steering Committee Meeting #5 April 3, 2024 - Agenda

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan Update

AGENDA

Wednesday, April 3, 2024
1:00 PM– 2:30 PM
Online only
via Microsoft Teams meeting
Join on your computer, mobile app or room device
Click here to join the meeting
Meeting ID: 246 787 193 33
Passcode: nhsc8w

Welcome and Introductions	5 minutes
Review and adopt notes from 3/13/24	5 minutes
Updates	5 minutes
DOGAMI Multi-hazard Risk Analysis	30 minutes
Risk Assessment – final factors and big picture review	20 minutes

Discussion: How does this information inform our assessment of Vulnerability for each of the hazards?

- Vulnerability Assessment using Poll Everywhere and Survey Monkey
- Maximum Threat Assessment using Poll Everywhere and Survey Monkey

Public Outreach brainstorm	10 minutes

Next Steps: July Steering Committee meeting and Public Outreach in August/September

Figure A-15. Steering Committee Meeting #5 April 3, 2024 - Notes

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan

Meeting Notes

Wednesday April 3, 2024 | 1:00 PM– 2:30 PM
Online via Teams only

Attendees: Katherine Daniel, Alyssa Boles, Kate Bentz, Julia Fox, Emerson Marsh, Kelly Hart, Elizabeth Coleman, Jason Rush, Joe Samaniego, Ron Whitlatch, Micki Valentine, Michele Eldridge, Matt Straite, Brandi Libra, Traci Archer, Jeff Carlson, Matt Williams

Review and Adopt 3/13/24 meeting notes: There were no corrections or additions suggested to these notes. Ric Lentz affirmed the notes without additions or corrections.

Updates on CWPP and IGAs: Katherine gave an update that the CWPP has been adopted and is in effect. IGAs are to be signed and approved by end of April. Katherine announced she had received some completed IGAs but not from every participating community.

Matt Williams DOGAMI Risk Assessment Presentation: The risk assessment is still mid-draft, results are not finalized and there are still some inconsistencies/data points to correct and fill out.

1. Background

DOGAMI is contracted to provide a risk assessment of specific hazards for the NHMP so communities can make informed decisions and identify specific mitigation opportunities locally.

2. Methods

The analysis is mainly looking at risk to structures within the NHMP study area for a select set of hazards (earthquake, flood, landslide, channel migration, wildfire, volcanic lahar). Analysis of critical infrastructure again, only looks at buildings, not other infrastructure (such as airport runways, bridges, water tanks, etc.)

Matt shares that as the Steering Committee views the results, we should be careful about comparing a hazard with other hazards, hazards are very different from each other. Hazard comparison should be done cross community not cross hazard (e.g. comparing landslide risk in Sodaville and Sweet Home, not comparing landslide and wildfire risk in Sodaville). Another thing to watch out for is that "Exposure" is different from "Damage"- e.g. the dollar value of buildings exposed will make up the total value of those buildings, the dollar value of damage may be partial values of those buildings- reflecting that not all damage equals total loss.

3. Results (see presentation slides in Box)

- Earthquake- comparison of Cascadia and crustal (fault line) earthquakes is ok because it's a similar hazard. Under Cascadia conditions, the whole county will be broadly affected and much more damage expected due to soil liquefaction. A crustal earthquake anticipates more damage

to specific communities with proximity to the Turner & Mill Creek fault line (particularly Scio, West Scio, Crabtree). The loss ratio for structures in both scenarios is roughly comparable.

- Flood- Matt Williams states that result tables for all hazards are based on a percentage of total structures within a community, so while certain communities have relatively high percentages of loss, they can also have very low # of structures so the overall impact might not be as high. (e.g. Shedd)
- Landslide- Landslides tend to disproportionately affect residential structures due to the tendency of people building homes on slopes/hillsides.
- Channel Migration- DOGAMI only mapped North Santiam River, so only Canyon communities of Gates, Lyons and Mill City included.
- Wildfire- High and moderate risk are included in damage analysis due to past experiences, it is important that wildfire risk is not understated.
- Volcanic Lahar- Santiam Canyon is the only place assessed for any volcanic exposure, due to proximity to Mt. Jefferson. This simulation is going to be re-run by Williams before the final report.

In the final report, each community will have a profile with a specific exposure analysis. Each community's specific critical facilities will be listed in a table which displays potential exposure to each hazard.

Kate Bentz asks about the availability of Channel Migration data for other rivers in the County, Matt Williams said that DOGAMI only has available data for the North Santiam, but Mill Creek may be another good candidate for that analysis.

Continuing the OEM-FEMA Methodology: Steering Committee participants are guided through interactive ranking polls for "Vulnerability" and "Maximum Threat" of hazards in Linn County.

Public Engagement and Input:

Katherine provides ideas for how each community can provide a space for public engagement and input in their communities.

- Linking to county website- Good for small communities to keep their community members informed, but not as useful for collecting feedback.
- Hosting an Open House event in the community or tabling at other events such as a farmers' market or community event- it is possible to provide an activity to engage the public and glean feedback from members of the community. Katherine is able to help with putting together.
- Launching a survey or posting flyers at public places- useful for dispersed communities

The project schedule has the public input period as July-August

Next Steps:

- Jurisdictions- send completed IGAs and any photos of natural hazard events to include in the plan
- DOGAMI will finish up the risk assessment and provide a final report

Figure A-16. Steering Committee Meeting #6 July 17, 2024 – Agenda

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan Update

AGENDA

Wednesday, July 17, 2024
3:00 PM– 4:30 PM
Hybrid meeting format

In person at: **OSU Extension Office**
33630 McFarland Rd, Tangent
Or

via Microsoft Teams: **Join the meeting now**
Meeting ID: 230 739 229 961
Passcode: 8SNHKe

Welcome 5 minutes

Review and adopt notes from 4/3/24 5 minutes

Schedule review 15 minutes

- Public Engagement
- Draft review and comment from Box
  - Community Profile
  - Risk Assessment Section 2

Public Outreach and Engagement work 15 minutes

- Risk Assessment Summary
- Survey examples
- Public engagement examples

Mitigation Strategy 30 minutes

- Mitigation Goals – review and revise if needed

  Goal 1: Enhance coordination and communication among Linn County stakeholders to implement the Plan.
  Goal 2: Protect life, the built environment and natural systems through County policies, procedures and services.
  Goal 3: Protect life, the built environment, the economy and natural resources through community-wide partnerships.

- Mitigation Actions
  - Good ones come from plans and policies already in place
  - Revising and adding new actions
  - Types of actions – Ongoing vs. Project-type actions
  - Elements of a complete action

- Review of Mitigation Strategy Actions

- Capability Assessment

Next Steps: Public Outreach in August/September, SC members review drafts, and individual jurisdiction meetings on mitigation strategy actions.

Figure A-17. Steering Committee Meeting #6 July 17, 2024 – Notes

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan Update

Meeting Minutes

Wednesday, July 17, 2024
3:00 PM – 4:30 PM
Hybrid Meeting Format
OSU Linn County Extension Office

Attendees: Katherine Daniel, Alyssa Boles, Kate Bentz, Julia Fox, Ginger Allen, Briana Parra, Kelly Hart, Ron Whitlatch, Jason Rush, Joe Samaniego, Traci Archer, City of Sodaville

Review and adopt notes from 4/3/24

- Meeting attendees moved to adopt the meeting minutes from April 3, 2024

Schedule review

- Katherine Daniel reviewed where Linn County was in the 2024/2025 NHMP project schedule as of July 2024. There are two drafts ready for review: the Community Profile and Risk Assessment

Public Outreach and Engagement work

- Risk Assessment Summary
- Survey examples
    - Kate Bentz shared a public outreach opportunity with the Sheriff's office at the Linn County Fair. She and Alyssa Boles will be operating a booth at the fair with engaging activities for both adults and children, including a three-question natural disaster community survey, interactive wildfire preparedness coloring sheets for children, and emergency and preparedness handouts. Julia Fox and Kate Bentz designed the survey in English and Spanish in the hopes of getting more engagement
- Public engagement examples
    - Ginger Allen suggested National Night Out event, taking place on the first Tuesday of August, as a good outreach event
    - Katherine Daniel recommended anyone choosing to engage at a public event should remember to take pictures

Mitigation Strategy

- Mitigation Goals – review and revise if needed
    - Kate Bentz suggested re-wording the written goals to better clarify and differentiate them better.
- Mitigation Actions
    - Kate Bentz suggested focusing on projects and programs people are seriously interested in accomplishing or participating in. Katherine Daniel suggested focusing on what is accomplishable inside of a set timeline, and that FEMA requires new NHMPs to identify potential funding sources for any strategies they include in their NHMP.
- Capability Assessment
    - Katherine Daniel encouraged stakeholders to consider their own capacity to implement any mitigation strategies they would like to adopt going forward

Next Steps:

- Jurisdictions- Commit to some kind of public outreach or survey in their community in August/September
- SC members- Katherine Daniel will be conducting individual jurisdiction meetings on mitigation strategy actions

Figure A-18. Steering Committee Meeting #7 October 23, 2024 – Agenda

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan Update

AGENDA

Wednesday, October 23, 2024
1:30 PM – 3:00 PM
Online Only meeting format

Section Break (Continuous)

via Microsoft Teams: Join the meeting now
Meeting ID: 253 862 011 585
Passcode: 73oxBD

Dial in by phone
+1 503-446-4951,,853679222# United States, Portland
Find a local number
Phone conference ID: 853 679 222#

Welcome and Introductions
→ City of Sweet Home and Lyons Rural Fire District → 10 minutes

Review and adopt notes from 7/17/24 → 5 minutes

Project updates → 20 minutes
- → Project Manager transition
- → Incorporation of City of Sweet Home and Lyons RFD
- → Public Engagement results; How long to leave survey open
- → DOGAMI Multi-hazard Risk Analysis
- → Drafts for review https://dlcd.box.com/s/udnp0iupr94zb8dk535s69aad2tj30d7

Mitigation Strategy and Capability Assessment → 30 minutes

→ **Breakout Rooms** →
- → What were the sources of mitigation actions for your city?
- → How would your jurisdiction prioritize mitigation actions?
- → What capacity does your jurisdiction have to implement mitigation strategies?
- → What skills, people, or resources would assist in implementing mitigation strategy actions?

Group Summary

Plan Maintenance: Discuss the process and schedule for plan maintenance and implementation → 15 minutes

Proposal: Project manager will request mitigation project updates using an online form every six months and an annual group meeting will be convened to prepare for grant applications and to identify support from state and federal agencies that would assist in implementation.

Next Steps: Transition to new project manager and completion of Mitigation Strategy for all addenda and for Section 3 of the Basic Plan (county's plan).

Figure A-19. Steering Committee Meeting #7 October 23, 2024 - Notes

Linn County
Multi-Jurisdictional
Natural Hazard Mitigation Plan Update

Minutes

Wednesday, October 23, 2024
1:30 PM– 3:00 PM
Online Only meeting format

Welcome and Introductions

Attendees include Kate Bentz, Katherine Daniel, Julia Fox, Ric Lentz, Ginger Allen, Jason Rush, Erik Anderson, Jason Ogden, Cecily Pretty, Matt Straite, Susan Millhauser, Jeff Carlson, Joe Samaniego, Traci Archer, Michelle Eldridge, Micki Valentine, Kevin Kreitman, Emily Hutchinson.

Welcome Jason Ogden from City of Sweet Home and Emily Hutchinson from the Lyons Rural Fire District (LRFD). Both of their jurisdictions have their own NHMP but are joining efforts to be incorporated with Linn County's overall NHMP. Welcoming Susan Millhauser as the new project lead from DLCD, to be replacing Katherine Daniel.

Review and adopt notes from 7/17/24

Committee Members voted to adopt the meeting minutes from the July 17, 2024 meeting.

Project updates

The county-wide online survey received 69 responses and was open to the public for 3 months. Discussion was had over leaving the survey open longer to allow the City of Sweet Home and Lyons Rural Fire District to conduct community outreach. Ric Lentz voiced concern that this may delay the completion of the NHMP updates, and reminded everyone that the county is currently out of compliance by having an outdated NHMP. Kate Bentz suggested Sweet Home and LRFD should push the survey out to their communities as soon as possible to keep the NHMP update on track.

Katherine reminded jurisdictions to review their pieces of the NHMP.

Mitigation Strategy and Capability Assessment

Breakout Rooms: attendees were divided into three breakout groups to discuss the following questions about their jurisdictions:

- What were the sources of mitigation actions for your city?
- How would your jurisdiction prioritize mitigation actions?
- What capacity does your jurisdiction have to implement mitigation strategies?
- What skills, people, or resources would assist in implementing mitigation strategy actions?

Group Summary
Most jurisdictions answered that they had sourced funds from the county and individual and community donations, and were looking for additional government and FEMA funding

opportunities. Most jurisdictions answered that they had looked at the natural hazards they have been responding to within the last few years to identify mitigation actions to prioritize. There was a general consensus that working with local jurisdiction staff, public works, and the local fire and school districts was a common place to check in for input and prioritizing mitigation actions. Many jurisdictions also commented that they choose to prioritize certain mitigation actions based on funding and staff capacity. Time constraints, limited staff with large workloads, and staff training were identified as limiting staff capacity to implement mitigation strategies among many jurisdictions. Having dedicated staff to focus on hazard mitigation work was identified as a helpful measure for implementing hazard mitigation. Some jurisdictions suggested pooling resources to hire a position at the county to oversee hazard mitigation projects within local jurisdictions.

Plan Maintenance:

Kate Bentz voiced a need for the NHMP committee to convene regularly without the follow-up meetings cutting into too much of people's time. She suggested using some meeting time for staff trainings and technical assistance that can assist local jurisdictions with their mitigation strategies. Ric Lentz let the group know he is required to host two meetings annually, and offered to host some of those meetings as the county's emergency coordinator. Ginger Allen voiced her intention to focus her attention on hazards inside her community, and wants future meetings to focus on supporting local jurisdictions with their individual needs and projects, and how jurisdictions can brainstorm and collaborate together.

Proposal: Project manager will request mitigation project updates using an online form every six months and an annual group meeting will be convened to prepare for grant applications and to identify support from state and federal agencies that would assist in implementation

Next Steps: Transition to new project manager and completion of Mitigation Strategy for all addenda and for Section 3 of the Basic Plan (county's plan).

Susan Millhauser introduced herself as the new NHMP Coordinator from DLCD. She will be helping the county complete the final phases of the NHMP. Next steps will include an opportunity for the public to comment on the NHMP, and needing to brainstorm how to get notices out to the public. Final Draft is set for final review in February 2025.

NHMP Survey Results

The Steering Committee conducted a survey between August 5, 2024, and October 31, 2024, to allow ample opportunity for the participating jurisdictions to promote the survey. 74 people responded to the survey. The survey was intended to gather information and feedback from community members to help county, city, and district leaders better understand how people have been impacted by natural hazards, their highest concerns, and to identify strategies to help reduce that risk. The results informed the Steering Committee's update of the Plan's risk assessment and mitigation strategy. Survey highlights include the following:

- Respondents live in a variety of urban and rural areas of Linn County.
- More than 50% of the respondents have been affected by power outages, followed by roads being blocked (34%), then property damage (30%). Two respondents from Lyons shared that they lost everything they have, while 24% of people noted they have never been impacted by a natural hazard event.
- The top four hazards of most concern were Wildfire (71%), followed by Winter Storms/Ice Storms (47%), Smoke and Poor Air Quality (42%), and Excessive Heat (36%).
- Landslide and Avalanche hazards were at the lower end of concern (86%) as were Volcanic eruptions (78%).
- The top three ways that residents receive information about how to protect their household and property from damage due to natural disaster include Linn-Benton ALERT (43% Always and 33% Sometimes), Community-run Facebook groups (25% Always and 41% Sometimes), and City or county social media (10% Always and 55% Sometimes). City or county website (5% Always and 35% Sometimes) and My child's school (6% Always and 38% Sometimes) were also noted.
- On the other end of the scale, respondents noted they never use the following means to receive information about natural disasters: Fact sheet/brochures (48%), Local newspapers (51%), Extension service (57%), and Workshops/meetings (60%).
- Respondents shared additional ways they receive information about how to protect from natural disasters, including email, text, 211info sharing, NOAA app, other social media (YouTube and Instagram), and word of mouth, among others.
- In response to the question about how people feel their community is doing to make people aware of the natural hazards they may face, the results were Fair (48%), Good (30%), Poor (18%), and Excellent (4%).
- 49% of respondents have an emergency kit, while 26% are working on it, and the remaining 25% do not have one.
- The barriers to getting an emergency kit included Cost (54%), Not sure what to put in it (30%), time (10%), and Don't see a need (7%). No one selected "Someone else will help me in an emergency."
- 52% of respondents have an emergency plan, 20% do not, and 27% are working on it.
- Barriers to making an emergency plan include I'm not sure how to make a plan (60%), Someone else will help me if there is a need (15%), Don't see a need (15%), and No interest (9%).
- The final survey question included questions and comments about the plan.

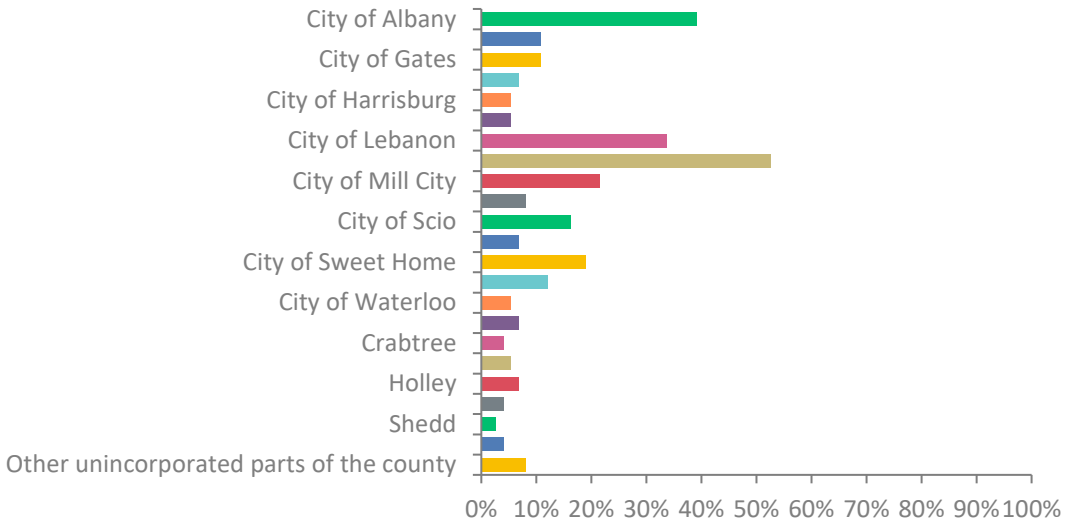
The survey questions and full results are included below as documentation and to serve as a resource for future planning efforts.

Linn County MJ-NHMP
Natural Hazards Risk Assessment Survey Results

Survey Period: 8/5/24-10/28/24
Total Responses: 74

Q1: What places in Linn County are you most familiar with?

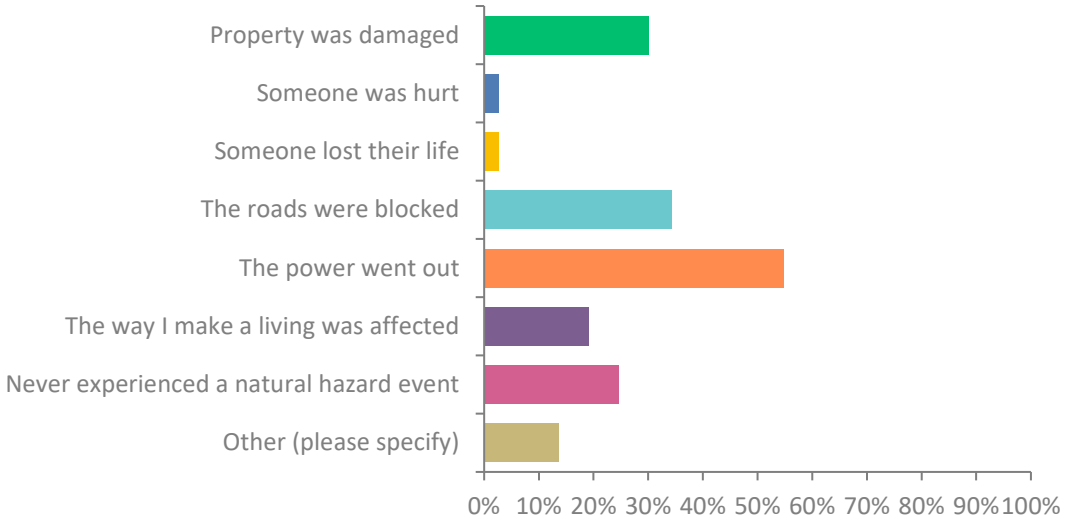
Answered: 74 Skipped: 0



ANSWER CHOICES	RESPONSES	
City of Albany	39.19%	29
City of Brownsville	10.81%	8
City of Gates	10.81%	8
City of Halsey	6.76%	5
City of Harrisburg	5.41%	4
City of Idanha	5.41%	4
City of Lebanon	33.78%	25
City of Lyons	52.70%	39
City of Mill City	21.62%	16
City of Millersburg	8.11%	6
City of Scio	16.22%	12
City of Sodaville	6.76%	5
City of Sweet Home	18.92%	14
City of Tangent	12.16%	9
City of Waterloo	5.41%	4
Cascadia	6.76%	5
Crabtree	4.05%	3
Crawfordsville	5.41%	4
Holley	6.76%	5
Peoria	4.05%	3
Shedd	2.70%	2
West Scio	4.05%	3
Other unincorporated parts of the county	8.11%	6
TOTAL		219

Q2: How were you affected by the natural hazard event?

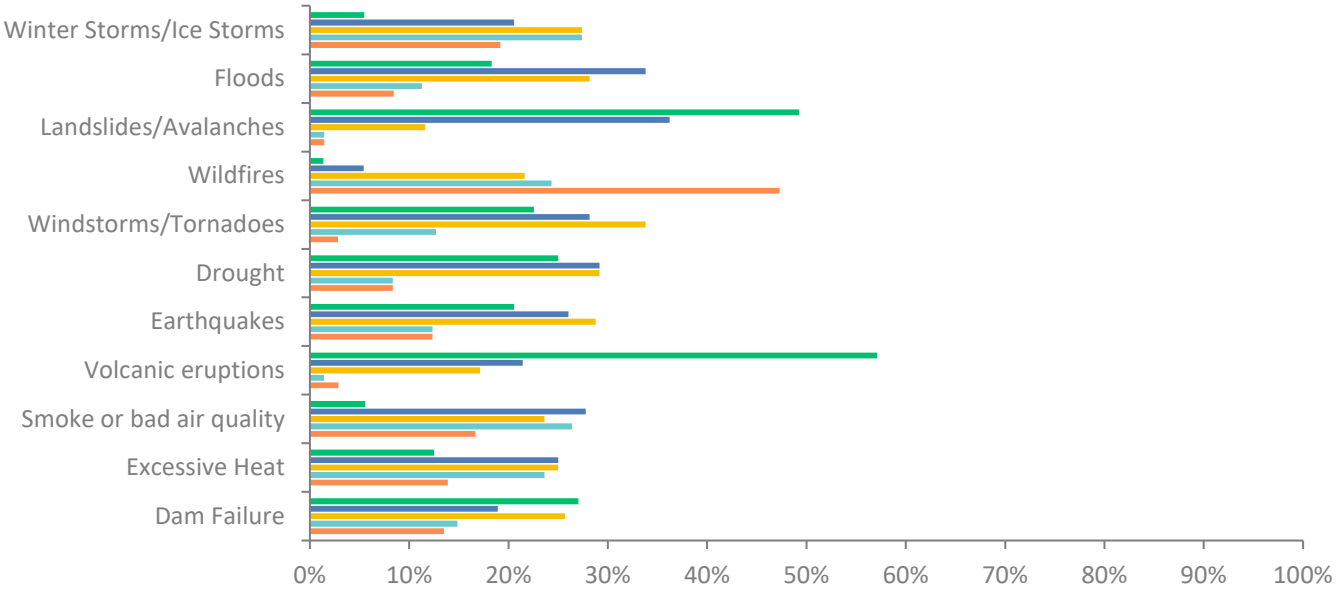
Answered: 73 Skipped: 1



ANSWER CHOICES	RESPONSES	
Property was damaged	30.14%	22
Someone was hurt	2.74%	2
Someone lost their life	2.74%	2
The roads were blocked	34.25%	25
The power went out	54.79%	40
The way I make a living was affected	19.18%	14
Never experienced a natural hazard event	24.66%	18
Other (please specify)	13.70%	10
TOTAL		133

Q3: What natural hazards concern you and your family most?

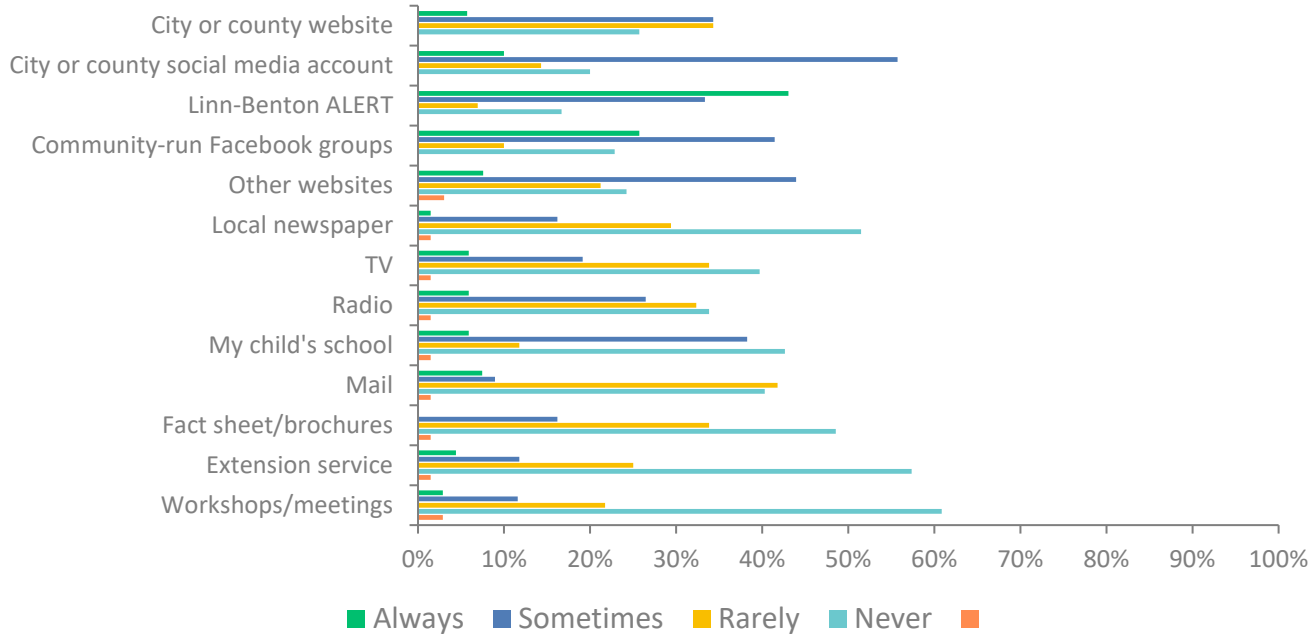
Answered: 74 Skipped: 0



	1 (NOT CONCERNED)	2	3	4	5 (EXTREMELY CONCERNED)	TOTAL
Winter Storms/Ice Storms	5.48% 4	20.55% 15	27.40% 20	27.40% 20	19.18% 14	73
Floods	18.31% 13	33.80% 24	28.17% 20	11.27% 8	8.45% 6	71
Landslides/ Avalanches	49.28% 34	36.23% 25	11.59% 8	1.45% 1	1.45% 1	69
Wildfires	1.35% 1	5.41% 4	21.62% 16	24.32% 18	47.30% 35	74
Windstorms/ Tornadoes	22.54% 16	28.17% 20	33.80% 24	12.68% 9	2.82% 2	71
Drought	25.00% 18	29.17% 21	29.17% 21	8.33% 6	8.33% 6	72
Earthquakes	20.55% 15	26.03% 19	28.77% 21	12.33% 9	12.33% 9	73
Volcanic eruptions	57.14% 40	21.43% 15	17.14% 12	1.43% 1	2.86% 2	70
Smoke or bad air quality	5.56% 4	27.78% 20	23.61% 17	26.39% 19	16.67% 12	72
Excessive Heat	12.50% 9	25.00% 18	25.00% 18	23.61% 17	13.89% 10	72
Dam Failure	27.03% 20	18.92% 14	25.68% 19	14.86% 11	13.51% 10	74

Q4: How do you presently receive information on how to protect your household and property from damage due to natural disaster?

Answered: 73 Skipped: 1



	ALWAYS	SOMETIMES	RARELY	NEVER	(NO LABEL)	TOTAL
City or county website	5.71% 4	34.29% 24	34.29% 24	25.71% 18	0.00% 0	70
City or county social media account	10.00% 7	55.71% 39	14.29% 10	20.00% 14	0.00% 0	70
Linn-Benton ALERT	43.06% 31	33.33% 24	6.94% 5	16.67% 12	0.00% 0	72
Community-run Facebook groups	25.71% 18	41.43% 29	10.00% 7	22.86% 16	0.00% 0	70
Other websites	7.58% 5	43.94% 29	21.21% 14	24.24% 16	3.03% 2	66
Local newspaper	1.47% 1	16.18% 11	29.41% 20	51.47% 35	1.47% 1	68
TV	5.88% 4	19.12% 13	33.82% 23	39.71% 27	1.47% 1	68
Radio	5.88% 4	26.47% 18	32.35% 22	33.82% 23	1.47% 1	68
My child's school	5.88% 4	38.24% 26	11.76% 8	42.65% 29	1.47% 1	68
Mail	7.46% 5	8.96% 6	41.79% 28	40.30% 27	1.49% 1	67
Fact sheet/brochures	0.00% 0	16.18% 11	33.82% 23	48.53% 33	1.47% 1	68
Extension service	4.41% 3	11.76% 8	25.00% 17	57.35% 39	1.47% 1	68
Workshops/meetings	2.90% 2	11.59% 8	21.74% 15	60.87% 42	2.90% 2	69

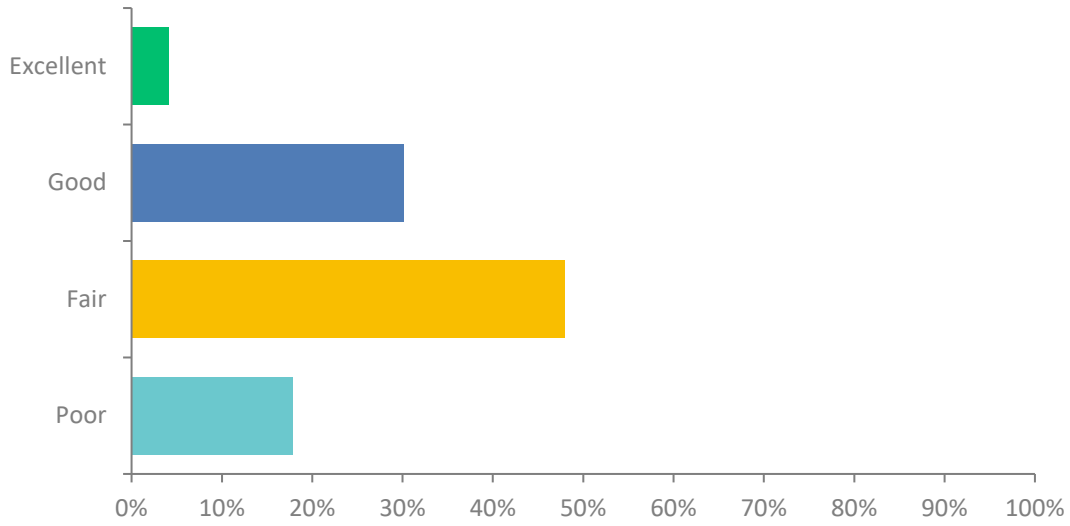
Q5: If there are other ways you currently receive information on how to protect your household and property from damage due to natural disasters, please let us know.

Answered: 30 Skipped: 44

- We depend on each other. There is absolutely no support from the progressives that run sweet home
- YouTube
- Chat GPT, other neighbors, NOAA App for iphone, electrician
- Word of mouth
- Noaa and the weather channel
- Social media
- Text
- 211info sharing info during an event
- Texts and messages from friends
- Through work at City of Lebanon and Lebanon Fire District
- Word of mouth; Instagram account I follow
- Text
- Text
- Brochures
- Email
- Networking
- Probably email.
- Experience past work history
- Have a term limit on the Commissioners. They need to go, they are WOKE!! All three are Rhino's!
- YouTube and social media
- I just call and ask directly

Q6: How do you feel your community is doing to make people aware of the natural hazards that they may face?

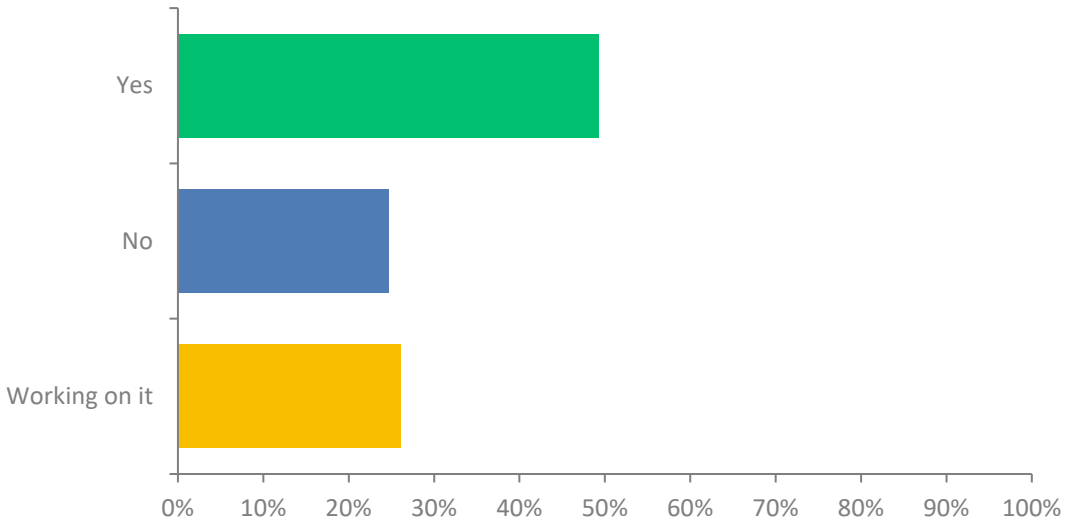
Answered: 73 Skipped: 1



ANSWER CHOICES	RESPONSES	
Excellent	4.11%	3
Good	30.14%	22
Fair	47.95%	35
Poor	17.81%	13
TOTAL		73

Q7: Do you and your family have an emergency kit?

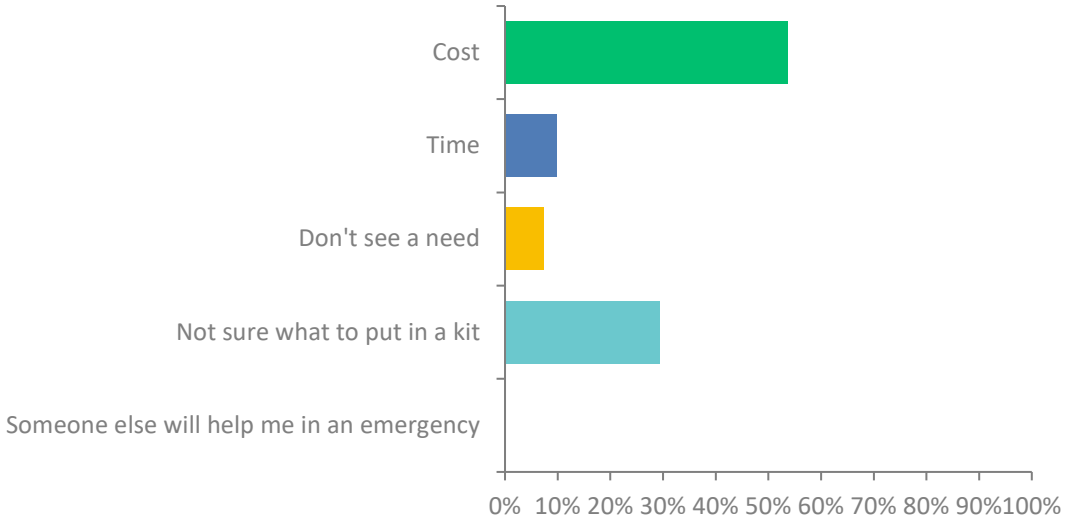
Answered: 73 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	49.32%	36
No	24.66%	18
Working on it	26.03%	19
TOTAL		73

Q8: If you do not have a kit, what is the reason?

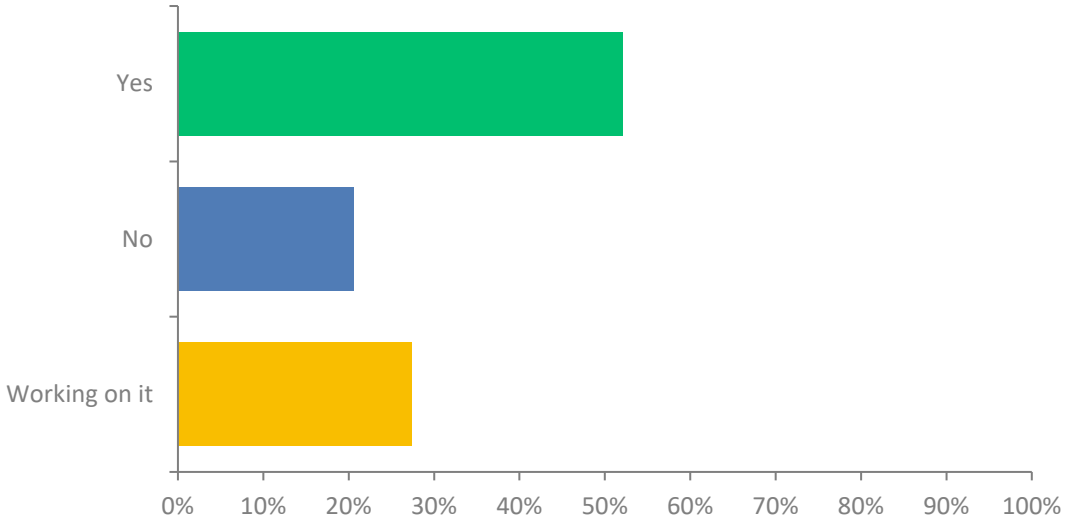
Answered: 41 Skipped: 33



ANSWER CHOICES	RESPONSES	
Cost	53.66%	22
Time	9.76%	4
Don't see a need	7.32%	3
Not sure what to put in a kit	29.27%	12
Someone else will help me in an emergency	0.00%	0
TOTAL		41

Q9: Do you or your family have an emergency plan?

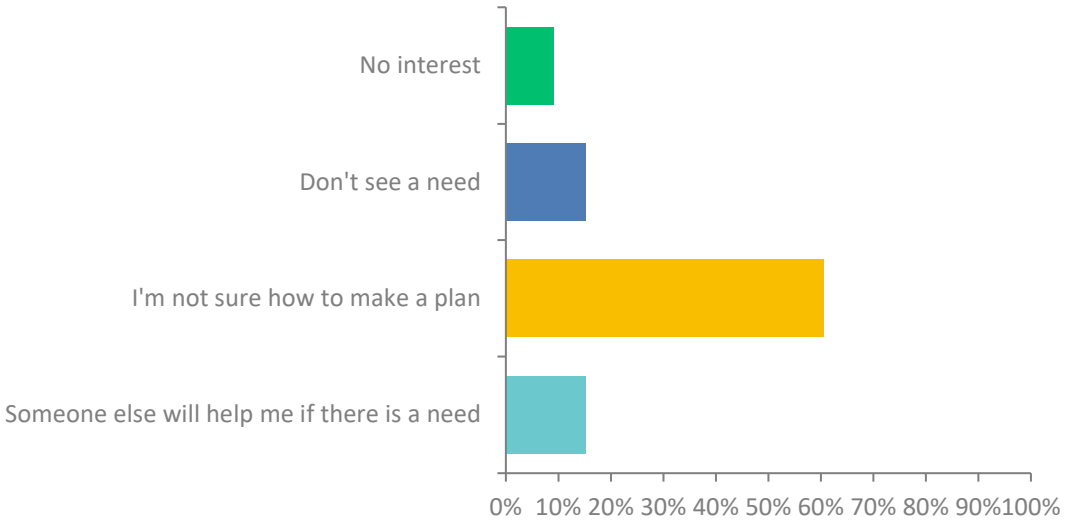
Answered: 73 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	52.05%	38
No	20.55%	15
Working on it	27.40%	20
TOTAL		73

Q10: If you do not have a plan, what is the reason why?

Answered: 33 Skipped: 41



ANSWER CHOICES	RESPONSES	
No interest	9.09%	3
Don't see a need	15.15%	5
I'm not sure how to make a plan	60.61%	20
Someone else will help me if there is a need	15.15%	5
TOTAL		33

Q11: Linn County and its cities are currently updating our Natural Hazards Mitigation Plan. The plan will help you, county, and city leaders better understand your risk of natural hazards and help to reduce that risk. To see a copy of the existing plan visit (Linn County 2017 NHMP). Please share any question or comments that you have about the plan.

Answered: 15 Skipped: 59

- The Californians, and other unworthy transplants moving here are the biggest threat we face
- just a side project but cities should work on maybe upgrading old bomb shelters for disasters and emergencies because they can no longer hold a large capacity of people
- The county does a horrible job on preparing for weather events in the long-term range nor has an urge to insure Linn County residents are safe during a storm.
- How are you getting feedback and sharing information to those whose primary language is not English?
- I can't click this link for the plan while doing mobile on my Facebook app. fYI.
- More of this!
- We are new to the area from Keizer and have not made a plan for a hazardous emergency.
- A mailer/brochure sharing key/critical operations/safety locations/resources would be great! Thanks!
- Will it affect my insurance?
- Please don't raise our taxes. I'm getting old and need to fix our house.
- Consistency with Marion County
- Need new commissioners and new sheriff!! All fake
- Clear chain of command when Cascadia Earthquake hits
- The consideration of "moderate" as the designation for east linn county woods

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APPENDIX B: COMMUNITY PROFILE

TABLE OF CONTENTS

Introduction B-1
Natural Environment Profile B-2
- History, Location, and Geography B-2
- Climate B-2
- Mountain Ranges B-3
- Rivers B-4
- Soils and Other Geologic Features B-5
- Major Regions and Land Cover B-5
- Land Ownership B-7
- Impact of Changing Climate B-8

Demographic Profile B-9
- Age B-10
- Language B-12
- Ethnicity and Race B-13
- Households B-16
- Income B-16
- Education B-18
- Health and Housing Access B-21
- Summary B-21

Economic Profile B-21
- Regional Affordability B-22
- Economic Diversity B-24
- Employment and Wages B-25
- Industry B-26
- Summary B-30

Built Environment Profile B-31
- Land Use and Development Patterns B-31
- Changes in Development B-34
- Housing B-35
- Critical and Essential Facilities B-38
- Infrastructure Profile B-40
- Summary B-44

Community Connectivity Profile B-44
- Social Services and Community Networks B-44
- Cultural Resources B-45
- Community Stability B-47
- Summary B-49

Political and Regulatory Profile B-50
- Oregon's Regulatory Framework B-50
- Government Structure B-52
- Existing Plans and Policies B-53

LIST OF FIGURES

Figure B-1. Understanding Risk 1
Figure B-2. Linn County Average Annual Precipitation 3
Figure B-3. Linn County Rivers and Physiography 4
Figure B-4. Linn County Community and Ecoregion Map 6
Figure B-5. Linn County Land Cover Map 7
Figure B-6. Linn County Land Ownership Map 8
Figure B-7. Linn County and Communities 10
Figure B-8. Select Demographics of Homeless Individuals in Linn County, 2023 21
Figure B-9. Unemployment Rate in the Mid-Willamette Valley, 2004-2024 25
Figure B-10. Linn County Labor-shed 26
Figure B-11. Projected Employment Change in Linn and Benton Counties, 2022-2032 28
Figure B-12. Annual Change in Wages by Job Sector, 2020-2021 30
Figure B-13. Selected Detail for Change in Job Earnings by Sector 30
Figure B-14. Linn County Land Ownership Map 32
Figure B-15. Population Density Map of Linn County, Oregon 33
Figure B-16. Residential Structures by Year Built in Linn County and its Cities 38
Figure B-17. Linn County Critical Facilities 39
Figure B-18. Linn County Transportation Routes 42

LIST OF TABLES

Table B-1. Population Estimates 9
Table B-2. Median Age and Percentage of People 15-44 years 11
Table B-3. Age Dependency Ratios 12
Table B-4. English Proficiency in Linn County and its Cities 13
Table B-5. Racial Composition of Linn County and its Cities 14
Table B-6. Households in Linn County and its Cities 15
Table B-7. Median Household Income 2015 and 2022 17
Table B-8. Poverty Status in the Past 12 Months in Linn County and its Cities. 18
Table B-9. Educational Attainment in Linn County and its Cities 20
Table B-10. Regional and Local Income Equality (GINI Index) 23
Table B-11. Household Spending >30% of Income on Housing 24
Table B-12. Regional Herfindahl Index Scores 25
Table B-13. Mid-Willamette Valley Industry Employment Projections 2022-2032 for Linn, Marion, Polk, and Yamhill counties 28
Table B-14. Linn County Issued Building Permits Summary 34
Table B-15. Housing Occupancy and Structure Type 37
Table B-16. Unincorporated Linn County (Rural) Critical Facilities by Type 39
Table B-17. Regional Residential Stability 48
Table B-18. Housing Tenure and Vacancy 49

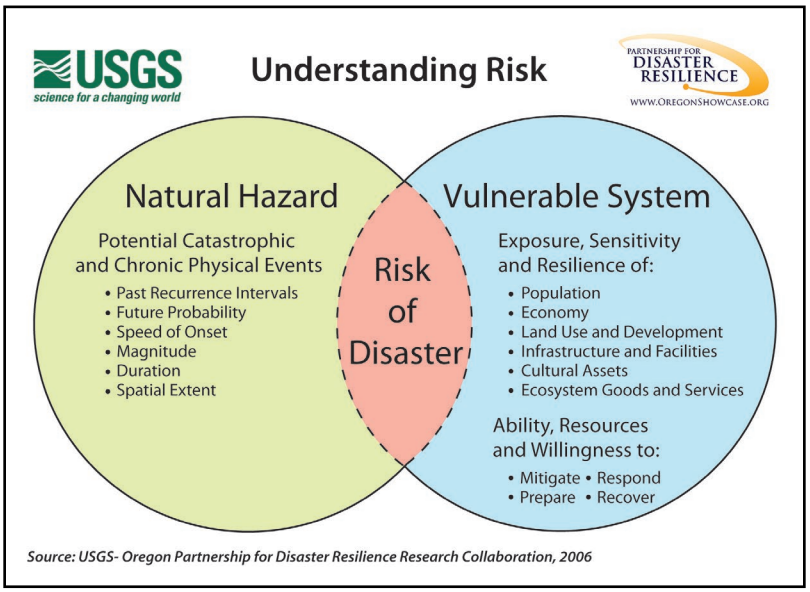
Introduction

The following section describes Linn County from a number of perspectives in order to help define and understand the county's sensitivity and resilience to natural hazards. Sensitivity factors can be defined as those community assets and characteristics that may be impacted by natural hazards, such as special populations, economic factors, and historic and cultural resources. Community resilience can be defined as the community's ability to manage risk and adapt to natural hazard impacts. In order to help define and understand the County's sensitivity and resilience to natural hazards, the following capacities must be examined:

- Natural Environment
- Social/Demographic
- Economic
- Built Environment
- Community Connectivity
- Political

The Community Profile describes the sensitivity and resilience to natural hazards of Linn County as they relate to each capacity. It provides a snapshot in time when the plan was developed and will assist in preparation for a more resilient community. The information in this section, along with the hazard assessments located in Section 2, Risk Assessment, should be used as the local level rationale for the risk reduction actions identified in Section 3, Mitigation Strategy. The identification of actions that reduce the county's sensitivity and increase its resilience can assist in reducing overall risk. This can be shown as the area of overlap in Figure B-1.

Figure B-1. Understanding Risk



Significant Changes Since Previous Plan:

Information in this appendix was updated to account for changes in development and includes updated demographic information where available. In addition, significant content was added.

Natural Environment Profile

Linn County's natural environment is a product of geography, climate, ecozone, land use, and settlement patterns. Natural environment capacity is recognized as the geography, climate, and land cover of the area such as, urban, water and forested lands that maintain clean water, air and a stable climate.[1] Natural resources such as wetlands and forested hill slopes play significant roles in protecting communities and the environment from weather-related hazards, such as flooding and landslides. However, natural systems are often impacted or depleted by human activities adversely affecting community resilience.

History, Location, and Geography

Linn County is in the mid-Willamette Valley, in western Oregon, and covers an area of 2,292 square miles. It is bounded to the north by Marion County, to the west by Benton County, to the south by Lane County, to the east by Deschutes and Jefferson Counties, and to the northwest by Polk County. The elevation ranges from 125 feet along the Willamette River in western Linn County to 10,497 feet at the peak of Mt. Jefferson in eastern Linn County.

Linn County is subject to impacts from natural hazard events such as floods, severe winter storms, windstorms, landslides (mass movement), and wildfires. The impacts of past hazard events in Linn County have resulted in loss of life and property, economic losses, and damaged infrastructure.

Western Linn County is subject to stream flooding and ponding, such as occurred during the floods of 1964, 1974,1996, and 2012. Linn County experienced severe damage during the Columbus Day windstorm in 1962, and parts of southern and western Linn County were severely impacted by a windstorm in February of 2002. Eastern Linn County is susceptible to landslides, winter storms, and wildfire. In 2020, parts of Linn County were directly impacted by the Labor Day wildfires while other parts were impacted by smoke and poor air quality. Most recently, in January 2024 the county was impacted by a severe winter storm that resulted in damage and hazards related to snow and ice.

These types of chronic hazards can be expected to continue to impact the county in the future. The county may also be subject to impacts from future catastrophic hazards such as earthquakes and volcanoes. The risks from future natural disasters and the impacts of future disasters on the population, economy, and infrastructure will increase as areas with hazards become more heavily developed.

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. Estimated future climate conditions and possible impacts are also discussed.

Linn County has a diverse climate and geography. It includes broad, fertile bottomlands and terraces throughout the valley floor in the west, varied relief of the Cascade foothills, and the abundant forests and volcanic peaks of the Cascade Range in the east. Western Linn County is characterized by a temperate climate. Summers are warm and dry, but extremely

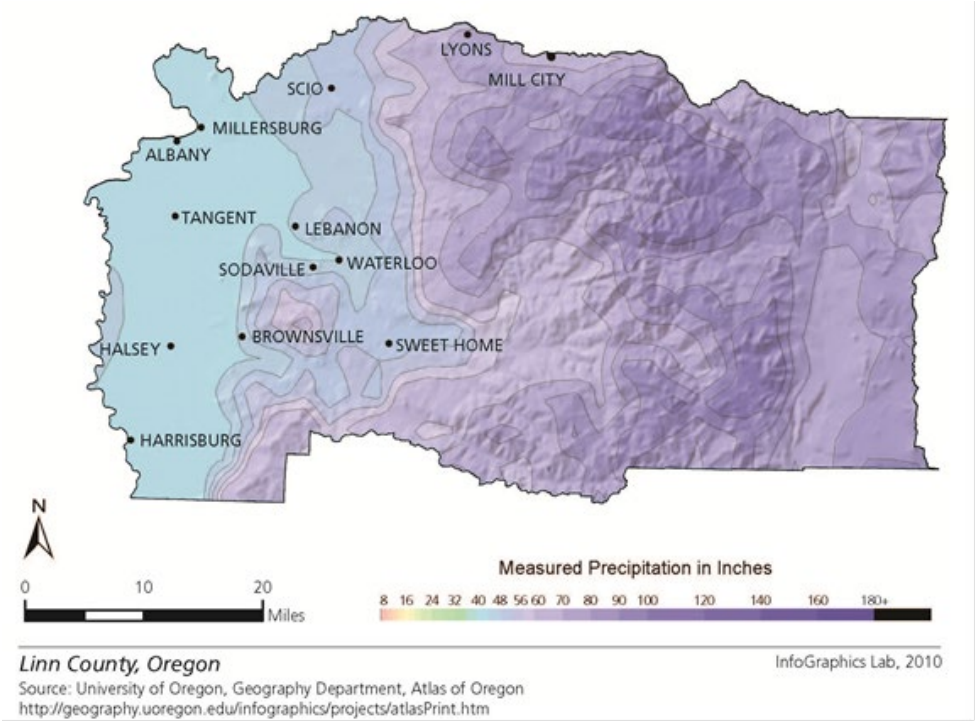
[1] Mayunga, J. 2007. Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. Summer Academy for Social Vulnerability and Resilience Building.

hot days are rare. Winters are cool and rainy, but snow and freezing temperatures are uncommon, except at higher foothill elevations.

Eastern Linn County consists of the higher elevations of the Cascade Range. Winters are colder with much more precipitation, much of it in the form of snow. Summers in the mountains are mostly dry with warm days, cool nights, and occasional lightning storms. Average annual precipitation on the valley floor is around 40 to 45 inches, occurring mostly between the months of October through March. Precipitation increases as the elevation rises east into the Cascade foothills. Annual precipitation at Foster is 54 inches, increasing to 62 inches at Cascadia, and 85 inches at the Santiam Pass.

In most winters, one or two storms bring strong and sometimes damaging winds. Heavy rains often result in localized flooding and ponding on the valley floor. In some years, heavy rainstorms can combine with rapid snow melt in the mountains to cause serious flooding.

Figure B-2. Linn County Average Annual Precipitation



Mountain Ranges

Nearly all of Linn County's population lives in the Willamette Valley between the Willamette River and the Cascade foothills. The eastern half of the county is primarily undeveloped forest land of the Cascade Range. The Cascades were formed by volcanic activity resulting from the convergence of two tectonic plates. Visible landmarks created by past volcanic activity include Snow Peak, Mount Washington, Mount Jefferson, and Three Fingered Jack. The tallest peak in Linn County is Mount Jefferson, at 10,497 feet.

Although mostly uninhabited, the Cascades draw large numbers of recreational visitors throughout the year. The rugged, steep mountains are subject to a variety of natural events, including lightning storms and wildfire during the hot summer and early fall months, severe storms during winter, and landslides in winter and spring.

Rivers

Linn County contains four major rivers and many smaller rivers, creeks, and drainages. The largest river in the county is the Willamette River. The Willamette River establishes Linn County's western boundary and flows past the communities of Harrisburg, Millersburg, Peoria, and Albany. The North Santiam River establishes most of the county's northern boundary and flows past the communities of Idanha, Gates, Mill City, and Lyons.

The South Santiam River and the Calapooia River watersheds are entirely within Linn County. The South Santiam River begins high in the Cascade Mountains and runs across the valley floor merging with the North Santiam River north of Albany. The South Santiam River flows through the communities of Cascadia, Sweet Home, Waterloo, and Lebanon. The Calapooia River runs from the Cascade foothills in southeast Linn County through the communities of Holley, Crawfordsville, and Brownsville before entering the Willamette River in Albany.

Other smaller drainages in Linn County include the Middle Fork of the Santiam River, Roaring River, Crabtree Creek, Thomas Creek, Hamilton Creek, McDowell Creek, Wiley Creek, Muddy Creek, Courtney Creek, and others. Combined with the many sloughs and low-lying areas on the valley floor, the county is highly susceptible to flood hazards. Linn County's rivers and general physiography are depicted in Figure B-3.

Figure B-3. Linn County Rivers and Physiography

Soils and Other Geologic Features

On the broad flood plains along the Willamette River and the lower reaches of the Santiam River system the soils are generally well drained. The soils on terraces and within remnant channels adjacent to the flood plains are sometimes characterized by internal drainage problems which can increase as they broaden and become nearly level to depressional.

Between the broad Willamette Valley terraces to the west and the mountainous uplands of the Cascade Range to the east are low foothills that range in elevation from 300 to 1,400 feet. The topography ranges from gently sloping areas on low plateaus to steep side slopes. The soils in these areas formed in material derived from igneous or sedimentary rock and are often poorly drained. The South Santiam and Calapooia Rivers, and minor streams such as Thomas and Crabtree Creeks, dissect these low foothills forming major and minor valleys that have both narrow flood plains and narrow stream terraces.

The mountainous uplands of the western Cascade Range have elevations up to 5,000 feet. The Cascades formed from volcanic material such as hard basalt and soft pyroclastic and sedimentary material. Volcanic ash covers much of the higher areas. The differences in the hardness of these materials account for the differing rates of dissection. The mountains are characterized by gently sloping soils on high plateaus and steep to very steep soils on canyon walls and side slopes. Steep headwalls and rolling slump blocks indicate slumping and landslide problems in some areas.

The Cascades are drained by tributaries of the Willamette River system. The upper valleys of the tributaries are narrow and have stream terraces of recent origin. The streams are characterized by waterfalls and numerous rapids until they reach the nearly level areas of the Willamette Valley.

The U.S. Army Corps of Engineers has built flood control dams on the North, South, and Middle Forks of the Santiam River. These structures have controlled much of the historic flooding in the lower reaches of the valleys, especially those of the Willamette Valley. Many areas that were active floodplains in the past are no longer subject to periodic flooding.

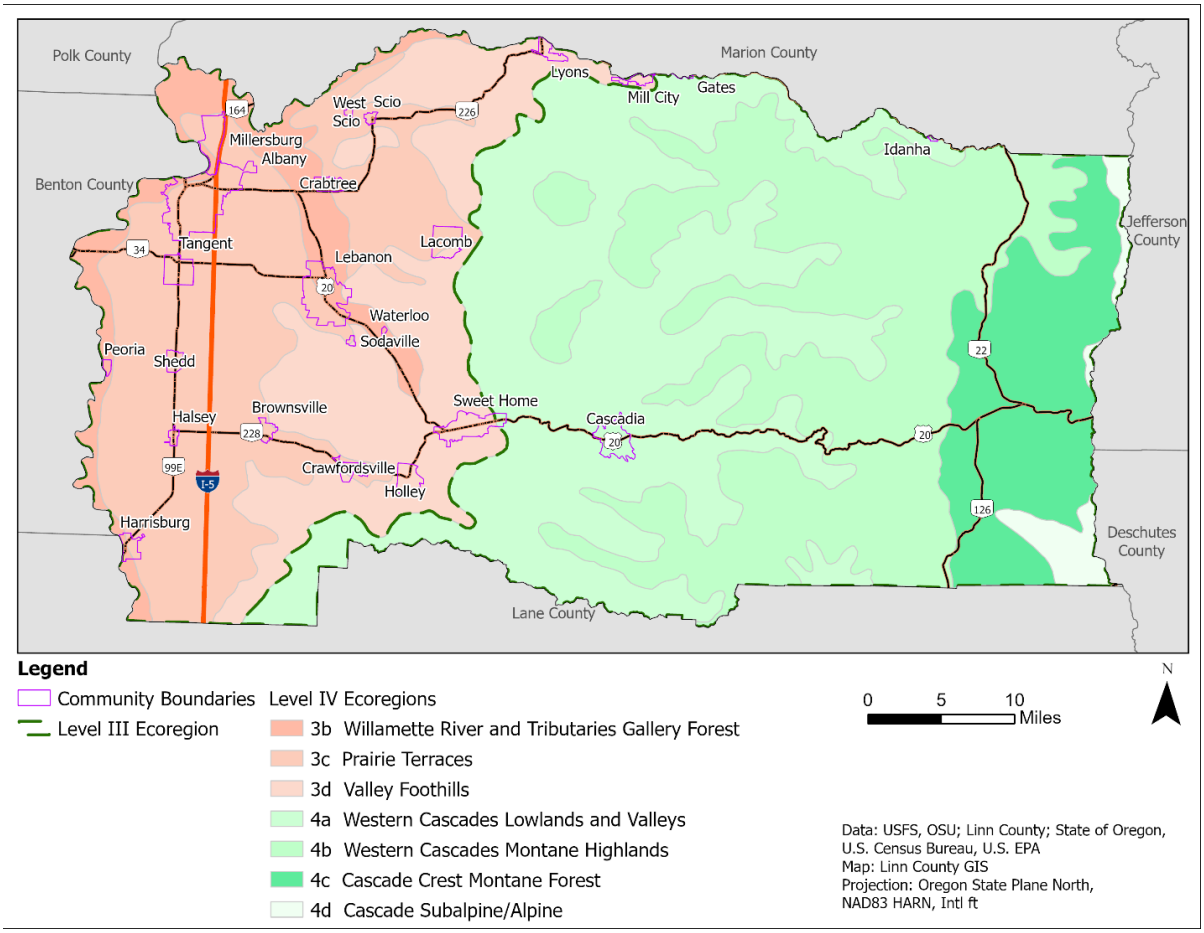
Major Regions and Land Cover[2]

Dynamic weather and diverse geography across Linn County are indicators of hazard vulnerability when combined with the changing climate and severe weather-related events. Both wet and dry cycles are likely to last longer and be more extreme, leading to periods of deeper drought and more frequent flash flooding. Less precipitation in the summers and subsequently lower soil moisture with hotter temperatures will likely increase the amount of vegetation, such as rangeland and grasslands, consumed by wildfire.

Linn County has a total land area of 2,292 square miles (1,477,760 acres). There are 15 incorporated communities, nine census designated places, and various dispersed unincorporated rural communities. In simple terms, the county can be thought of as two distinct regions- western and eastern. Roughly speaking, the western quarter of the county is within the Willamette Valley. This area is characterized by its extensive agricultural lands and populated areas. Moving easterly, the land use transitions into mixed farm/forest areas within the foothills of the Cascade Mountain Range. The eastern three quarters of the county is characterized by its sparsely populated forestland within the Cascades, as shown in Figures B-4 and B-5, below.

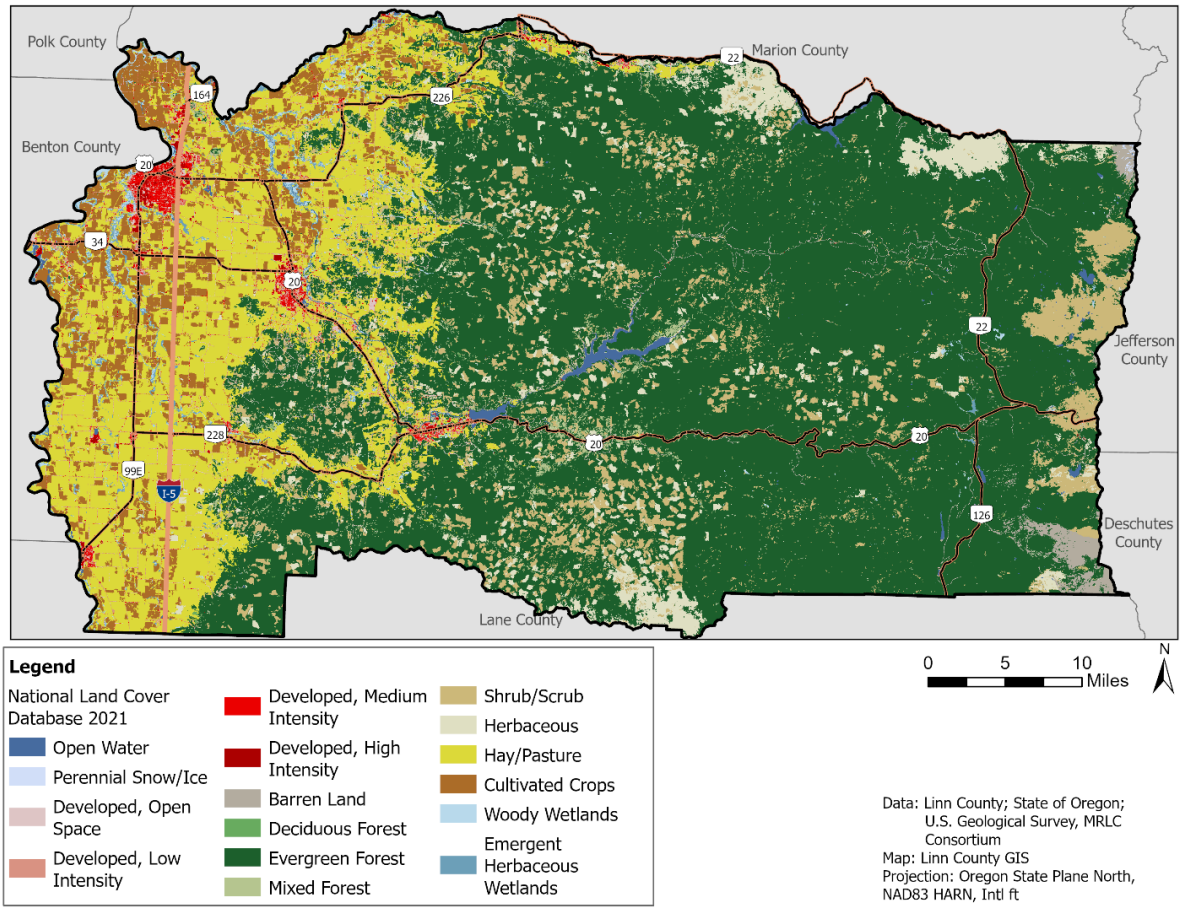
[2] From the Linn County Community Wildfire Protection Plan, 2024.

Figure B-4. Linn County Community and Ecoregion Map



Source: Linn County Community Wildfire Protection Plan, 2024.

Figure B-5. Linn County Land Cover Map



Source: Linn County Community Wildfire Protection Plan, 2024.

Land Ownership

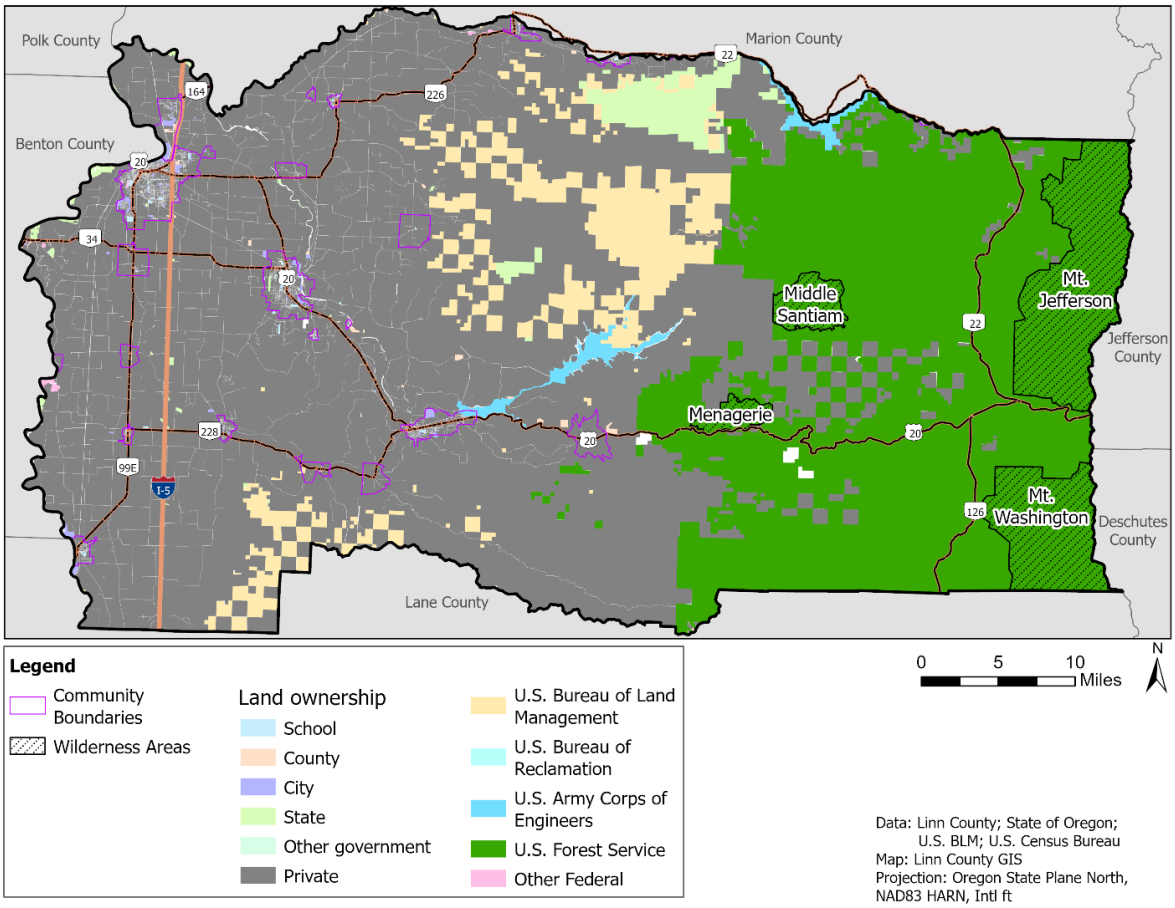
Most of all land within the County, 60% or approximately 890,242 acres, is under private ownership.[3] This includes urban areas, agricultural land, non-industrial forestland, and industrial timberland. Another third is in federal ownership, with approximately 462,508 acres managed by the US Forest Service (31%), 87,039 acres managed by the US Bureau of Land Management (6%), and just over 10,000 acres managed by other federal agencies such as U.S. Fish & Wildlife and the U.S. Army Corps of Engineers (<1% of all lands). The State of Oregon manages approximately 22,668 acres in Linn County (2%), including the Santiam State Forest south of Mill City and Gates. Minimal amounts of land are managed by county, city, and Tribal owners.

Different landowners and managers have a variety of highly valued resources and assets to protect. Landowners also differ in their usage and management practices, which can impact wildfire risk in a particular area. On federal lands there may be multiple objectives that drive how the land is managed. The USFS manages four Wilderness Areas that are at least partially located within Linn County: Menagerie Wilderness, Middle Santiam Wilderness, Mount Jefferson Wilderness, and Mount Washington Wilderness. Wilderness areas, as defined by the U.S. Wilderness Act of 1964, are intended to be preserved for their natural,

[3] Oregon Wildfire Risk Explorer – Advanced Report for Linn County, Accessed from the Oregon Wildfire Risk Explorer on February 13, 2023. Primary data Source: USDA Forest Service Pacific Northwest Quantitative Wildfire Risk Assessment (2018). Wildfire Risk Explorer (oregonexplorer.info)

untamed, undeveloped, and primitive characters. As a result, motorized equipment, permanent structures, use of motor vehicles, and other acts may be prohibited or severely restricted.[4] Other areas of public lands managed by USFS, BLM, and ODF may be actively managed for timber and have less strict usage guidelines when compared to Wilderness areas.

Figure B-6. Linn County Land Ownership Map



Source: Linn County Community Wildfire Protection Plan, 2024.

Impact of Changing Climate

The physical geography, weather, climate, and land cover of an area represent various interrelated systems that affect overall risk and exposure to natural hazards. The projected climate change models representing the Willamette Valley and the foothills of the Cascades indicate the potential for increased effects of hazards, particularly extreme heat, drought, and wildfire due to changing climate of the region. This region is projected to have warmer and drier summers with less precipitation. In addition, winter temperatures will be warmer, which means a decrease in mountain snowpack. However, the intensity of extreme precipitation is expected to increase as the atmosphere warms and holds more water vapor, potentially increasing localized flooding. These factors combined with periods of population growth and development intensification can lead to increasing risk of hazards, threatening loss of life, property and long-term economic disruption if land management is inadequate.

[4] "Regulations," Wilderness Connect https://wilderness.net/learn-about-wilderness/regulations.php

For additional information regarding future changes in climate and the influence on natural hazards in Linn County, see Appendix F: OCCRI Future Climate Projections, Linn County, OR.

Demographic Profile

The demographic composition of a community, the characteristics and nature of people in the community, may be factors in community resilience.

Table B-1 displays the population characteristics of Linn County and the cities within it; jurisdictions shown in **bold** are participating in this NHMP. Albany has the largest population (48,156) in Linn County, followed by Lebanon (20,329), Sweet Home (10,028), and Harrisburg (3,660). The City of Albany is not participating in this MJ-NHMP as it maintains a stand-alone Natural Hazards Mitigation Plan. Approximately one-third of the county's population resides in unincorporated areas.

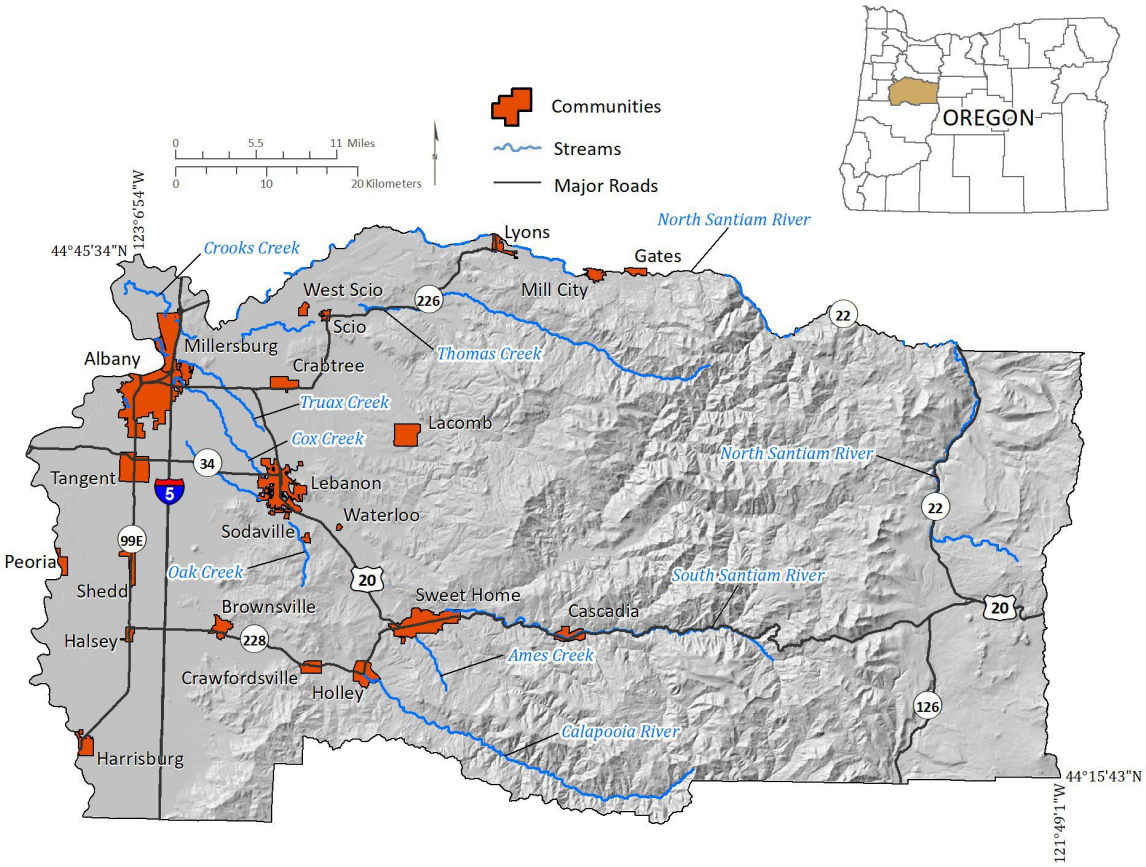
Between 2015 and 2023, Linn County experienced a slight increase in population overall while the unincorporated area had a slight decrease. The City of Millersburg experienced the highest population growth between 2015 and 2023.

Table B-1. Population Estimates

Jurisdiction	2015 Population	2020 Population	2023 Population	Annualized Change 2015 - 2023	Percent County Population
Linn County	**120,860**	**128,989**	**131,984**	**1.31 %**	
Albany*^	**44,403**	**47,409**	**48,156**	**1.21 %**	**36.5 %**
Brownsville	1,690	1,700	1,846	1.32 %	1.4 %
Gates**	**43**	**46**	**46**	**1.00 %**	**0.0 %**
Halsey	**915**	**963**	**952**	**0.58 %**	**0.7 %**
Harrisburg	**3,645**	**3,657**	**3,660**	**0.06 %**	**2.8 %**
Idanha**	62	71	70	1.84 %	0.1 %
Lebanon	**15,740**	**18,574**	**20,329**	**4.17 %**	**15.4 %**
Lyons	**1,160**	**1,207**	**1,203**	**0.53 %**	**0.9 %**
Mill City**	1,556	1,641	1,667	1.02 %	1.3 %
Millersburg	**1,620**	**2,926**	**3,153**	**13.52 %**	**2.4 %**
Scio	**850**	**957**	**949**	**1.66 %**	**0.7 %**
Sodaville	**325**	**360**	**357**	**1.41 %**	**0.3 %**
Sweet Home	**9,090**	**9,858**	**10,028**	**1.47%**	**7.6 %**
Tangent	**1,200**	**1,232**	**1,218**	**0.21 %**	**0.9 %**
Waterloo	230	222	216	-0.87 %	0.2 %
Unincorporated	**38,330**	**38,166**	**38,081**	**-0.09 %**	**28.9 %**

Source: Portland State University Population Research Center, 2023 Annual Population Reports Table, 4/16/24 & 12/4/24
*A part of the Albany population (9,841, 17%) is within Benton County.
**Parts of the total populations of Gates (506, 92%), Idanha (84, 54%), and Mill City (399, 20%) are in Marion County. Idanha and Mill City are part of the Marion County MNHMP, while the City of Gates is joining the Linn county MJ-NHMP for the first time.
^Albany has a stand- alone Natural Hazards Mitigation Plan

Figure B-7. Linn County and Communities



Source: DOGAMI Multi-Hazard Risk Report for Linn County, OR

Population size itself is not an indicator of vulnerability. More important is where people live and the capacity of people to be resilient in the face of natural hazard events. Research by social scientists demonstrates that some of the characteristics of the people in an area, such as language, race, age, income, education, and health, can relate to community resilience.

Age

Communities that are resilient have a mix of younger and older populations, and a growing number of working-age residents. Higher concentrations of older or younger populations require more services from the public, particularly during an economic disruption.[5] Median age of a population, proportion of the workforce over 55 years old, and age dependency ratio are several statistics that provide insight into the age structure of a community.

Median age is the age that falls exactly in the middle of the data. The percentage of the population of people over 55 and employed full-time is important because when the workforce is relying on an ageing population it may be less sustainable. The dependency ratio is the number of dependents in a population (under 18 and over 65) divided by the number of working-age (18-64) people, multiplied by 100. This data point describes the level of pressure on an economy from supporting the portions of the population least likely to be working. This statistic can also be broken down into the Old-age Dependency Ratio and the Child Dependency Ratio.

[5] University of Oregon, Institute for Policy Research and Engagement, Linn County Economic Resilience Profile.

The table below shows the median age, and the proportion of people aged 15-44 in each of the cities within, or partially within, Linn County. Jurisdictions shown in **bold** are participating in this NHMP. The cities in this list are ordered with the cities whose residents have the highest proportion of 15–44-year-olds at the top. This statistic roughly coincides with lower median ages.

Table B-2. Median Age and Percentage of People 15-44 years

Jurisdiction	Total Population	Number of people 15-44 yrs	Percentage of people 15-44 yrs	Median Age
Linn County	128,598	48,564	37.8%	40.0
Halsey	**1,419**	**626**	**44.1%**	**37.2**
Harrisburg	**3,663**	**1,579**	**43.1%**	**33.5**
Albany	56,348	23,464	41.6%	36.5
Lebanon	**18,587**	**7,661**	**41.2%**	**37.3**
Waterloo	238	97	40.8%	45.2
Tangent	**1,299**	**522**	**40.2%**	**40.1**
Mill City**	1,760	702	39.9%	35.8
Sweet Home	**9,852**	**3,667**	**37.2%**	**41.3**
Millersburg	**2,964**	**1,026**	**34.6%**	**40.0**
Brownsville	1,832	622	34.0%	44.0
Scio	**860**	**288**	**33.5%**	**40.7**
Sodaville	**364**	**116**	**31.9%**	**45.7**
Gates**	**451**	**132**	**29.3%**	**57.2**
Lyons	**1,175**	**310**	**26.4%**	**55.1**
Idanha**	141	18	12.8%	67.4

*Part of Albany is in Benton County.
**Parts of Gates, Idanha, and Mill City are in Marion County.
Source: US Census, 2022 American Community Survey 5-year estimates

As shown in Table B-3, below, the cities with the greatest number of children under 18 years old per hundred people potentially within the workforce are Mill City, Millersburg, Harrisburg, Scio, Halsey, and Albany. The cities with the greatest number of residents over 64 per hundred residents potentially in the workforce include Idanha, Gates, Lyons, Waterloo, and Brownsville. Jurisdictions shown in **bold** are participating in this NHMP.

The Oregon Office of Economic Analysis projects that, in 2035, there will be a higher percentage of the county population over the age of 64. As the population ages, Linn County may need to consider different mitigation and preparedness actions to address the specific needs of this group. The age dependency ratio for Linn County is expected to rise to 64.0 in 2035, largely because of increases in the >64 age cohort.

Table B-3. Age Dependency Ratios

Jurisdiction	Age Dependency Ratio	Old-age Dependency Ratio	Child Dependency Ratio
Linn County	**71.3**	**33.9**	**37.5**
Mill City**	82.4	29.1	53.3
Millersburg	**78.0**	**27.1**	**50.9**
Harrisburg	**62.8**	**12.0**	**50.8**
Scio	**79.5**	**33.2**	**46.3**
Halsey	**57.5**	**17.3**	**40.2**
Albany	66.7	26.7	40.0
Brownsville	72.7	35.6	37.0
Lebanon	**66.7**	**31.1**	**35.6**
Gates**	**90.3**	**54.9**	**35.4**
Sweet Home	**63.5**	**29.0**	**34.5**
Tangent	**51.6**	**21.4**	**30.2**
Sodaville	**53.6**	**24.5**	**29.1**
Lyons	**71.5**	**45.1**	**26.4**
Waterloo	59.7	39.6	20.1
Idanha**	182.0	178.0	4.0

**Parts of Gates, Idanha, and Mill City are in Marion County.
Source: US Census, 2022 American Community Survey 5-year estimates

The age profile of an area has a direct impact both on what actions are prioritized for mitigation and how responses to hazard incidents are carried out. School age children rarely make decisions about emergency management. As the youth population increases, so will the need to increase outreach efforts to schools and parents. Effective ways to teach children about fire safety, earthquake response, and evacuation plans will become paramount. Furthermore, children are more vulnerable to the heat and cold, have few transportation options, and require assistance to access medical facilities. Older populations, as well as people with functional disabilities, may also have special needs prior to, during, and after a natural disaster. They may require assistance in evacuation due to limited mobility or health issues. Additionally, older populations and people with functional disabilities may require special medical equipment or medications and can lack the social and economic resources needed for post-disaster recovery.[6]

Language

Special consideration should be given to communicating with people who do not speak English as their primary language. In general, language barriers can be a challenge. Thus, special attention must be given to effective communication when disseminating hazard planning and mitigation resources to the general public. Being less informed will translate into being less prepared.

There are various languages spoken across Linn County; the primary language is English. Overall, 2.9% of the total population 5 years and over in Linn County is not proficient in

6 Wood, Nathan. Variations in City Exposure and Sensitivity to Tsunami Hazards in Oregon. U.S. Geological Survey, Reston, VA, 2007.

English. Albany has the largest population of residents 5 years and over who have limited or no English-speaking ability (2,175, 4.2%). Outreach materials used to communicate with, plan for, and respond to non-English speaking populations should take into consideration the language needs of these populations.

Table B-4. English Proficiency in Linn County and its Cities

Jurisdiction	Population 5 years and over	Speak English Only		Speak English only or speak English "very well"		Speak English less than "very well"	
	Number	Number	Percent	Number	Percent	Number	Percent
Linn County	121,266	111,632	92.10%	117,744	97.10%	3,522	2.90%
Albany	52,192	46,505	89.10%	50,017	95.80%	2,175	4.20%
Brownsville	1,760	1,696	96.40%	1,760	100.00%	0	0.00%
Gates	440	423	96.14%				
Halsey	1,323	1,323	100.00%	1,323	100.00%	0	0.00%
Harrisburg	3,300	3,287	99.60%	3,300	100.00%	0	0.00%
Lebanon	17,713	16,001	90.30%	16,851	95.10%	862	4.90%
Lyons	1,108	1,081	97.60%	1,096	98.90%	12	1.10%
Mill City	1,628	1,507	92.60%	1,583	97.20%	45	2.80%
Millersburg	2,758	2,631	95.40%	2,726	98.80%	32	1.20%
Scio	763	728	95.40%	756	99.10%	7	0.90%
Sodaville	347	336	96.80%	343	98.80%	4	1.20%
Sweet Home	9,432	8,855	93.90%	9,416	99.80%	16	0.20%
Tangent	1,254	1,167	93.10%	1,206	96.20%	48	3.80%
Waterloo	234	224	95.70%	232	99.10%	2	0.90%

Source: U.S. Census Bureau, 2022 American Community Survey 5-year estimates, Table S1601

Ethnicity and Race

It is important to identify specific ways to support all portions of the community through hazard mitigation, preparedness, and response. Culturally appropriate outreach can include both methods and messaging targeted to diverse audiences. For example, connecting to historically disenfranchised populations through already trusted sources or providing preparedness handouts and presentations in the languages spoken by the population can help to increase overall community resilience.

Historic patterns of inequality along racial or ethnic lines have often resulted in minority communities that are more likely to be impacted in terms of loss and the ability to recover following a disaster. Studies have shown that that these communities can be more vulnerable to natural disaster events. This is not reflective of individual characteristics; rather members of these communities may live in locations with inferior building stock, degraded infrastructure, or less access to public services. The table below describes Linn County's population by race and ethnicity. Most of the population in Linn County is racially White (81%) and 9.8% of the population is ethnically Hispanic or Latino. Asian, American Indian and Alaska Native, Black or African American, Native Hawaiian and Other Pacific Islander, and people of two or more races comprise other smaller minority populations in Linn County.

Table B-5. Racial Composition of Linn County and its Cities

	Linn County, Oregon		Albany	Brownsville	Gates	Halsey	Harrisburg	Lebanon	Lyons	Mill City	Millersburg	Scio	Sodaville	Sweet Home	Tangent	Waterloo
	128,610		56,472	1,694	548	962	3,652	18,447	1,202	1,971	2,919	956	360	9,828	1,231	222
Hispanic or Latino	12,571	9.8%	14.1%	3.5%	4.4%	8.9%	10.9%	7.9%	4.7%	8.6%	7.5%	4.0%	5.8%	5.8%	11.5%	6.8%
Not Hispanic or Latino:	116,039	90.2%	85.9%	96.5%	95.6%	91.1%	89.1%	92.1%	95.3%	91.4%	92.5%	96.0%	94.2%	94.2%	88.5%	93.2%
Population of one race:	108,396	84.3%	80.1%	91.1%	89.8%	86.6%	82.7%	86.2%	90.1%	85.1%	87.0%	90.0%	87.2%	86.9%	82.5%	88.7%
White alone	104,118	81.0%	75.8%	87.5%	84.3%	84.8%	80.7%	82.8%	87.4%	82.7%	83.9%	86.3%	83.9%	84.0%	80.5%	86.5%
Asian alone	1,434	1.1%	1.7%	1.6%	0.7%	0.3%	0.5%	1.3%	1.0%	0.3%	1.6%	0.8%	0.8%	0.7%	0.6%	0.5%
American Indian and Alaska Native alone	1,283	1.0%	0.9%	0.9%	1.6%	0.8%	0.9%	1.0%	1.1%	1.5%	0.5%	0.7%	0.6%	1.3%	0.7%	1.4%
Some Other Race alone	658	0.5%	0.5%	0.3%	2.6%	0.0%	0.3%	0.4%	0.3%	0.3%	0.8%	1.0%	1.4%	0.5%	0.4%	0.0%
Black or African American alone	623	0.5%	0.8%	0.8%	0.5%	0.2%	0.1%	0.5%	0.2%	0.3%	0.1%	0.8%	0.6%	0.3%	0.2%	0.0%
Native Hawaiian and Other Pacific Islander alone	280	0.2%	0.3%	0.0%	0.0%	0.4%	0.2%	0.3%	0.1%	0.1%	0.1%	0.2%	0.0%	0.1%	0.0%	0.5%
Population of two or more races:	7,643	5.9%	5.9%	5.4%	5.8%	4.5%	6.4%	5.9%	5.2%	6.3%	5.4%	6.1%	6.9%	7.3%	6.0%	4.5%
Population of two races:	7,245	5.6%	5.5%	4.8%	5.7%	4.4%	6.0%	5.6%	4.8%	5.7%	5.3%	6.0%	6.4%	7.0%	5.4%	4.1%
White; American Indian and Alaska Native	3,667	2.9%	2.5%	2.1%	4.2%	2.0%	2.7%	2.7%	3.7%	4.2%	1.8%	3.8%	2.8%	4.0%	3.0%	0.0%
White; Some Other Race	1,675	1.3%	1.1%	1.1%	0.4%	1.5%	1.6%	1.3%	0.1%	0.6%	1.7%	0.9%	0.3%	1.6%	1.1%	2.3%
White; Asian	908	0.7%	1.1%	0.4%	0.4%	0.4%	0.7%	0.7%	0.2%	0.2%	1.0%	0.2%	1.9%	0.4%	0.5%	1.4%
White; Black or African American	623	0.5%	0.6%	0.8%	0.2%	0.4%	0.8%	0.5%	0.6%	0.2%	0.5%	0.4%	1.4%	0.5%	0.2%	0.0%
White; Native Hawaiian and Other Pacific Islander	225	0.2%	0.1%	0.3%	0.4%	0.0%	0.0%	0.2%	0.2%	0.5%	0.4%	0.6%	0.0%	0.3%	0.3%	0.5%
Asian; Native Hawaiian and Other Pacific Islander	46	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%
Black or African American; American Indian and Alaska Native	40	0.0%	0.0%	0.1%	0.0%	0.1%	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Black or African American; Native Hawaiian & Other Pacific Islander	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Black or African American; Asian	12	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Black or African American; Some Other Race	9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
American Indian and Alaska Native; Asian	9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Asian; Some Other Race	8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
American Indian and Alaska Native; Some Other Race	7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Population of three races:	364	0.3%	0.3%	0.6%	0.2%	0.1%	0.4%	0.3%	0.2%	0.6%	0.1%	0.1%	0.6%	0.3%	0.4%	0.5%
Population of four races:	29	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%
Population of six races:	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: 2020 Decennial Census, Table P9

Table B-6. Households in Linn County and its Cities

	Linn County		Albany	Browns-ville	Gates	Halsey	Harris-burg	Lebanon	Lyons	Mill City	Millers-burg	Scio	Sodaville	Sweet Home	Tangent	Waterloo
Total households	49,944		21,484	774	206	445	1,271	7458	508	597	1,059	331	139	3,922	464	73
Household by Type	**Estimate**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**
Married-couple household	25,685	51.4%	48.9%	55.4%	49.0%	60.2%	53.4%	40.3%	58.7%	43.0%	76.5%	58.9%	53.2%	45.4%	54.1%	60.3%
With children of the householder under 18 years	9,062	18.1%	21.1%	19.8%	16.0%	21.1%	28.7%	14.7%	11.6%	17.8%	33.2%	23.3%	12.2%	14.7%	18.5%	11.0%
Cohabiting couple household	3,906	7.8%	8.7%	7.0%	8.7%	5.2%	10.7%	6.5%	7.3%	12.6%	4.2%	6.6%	10.1%	12.8%	7.3%	0.0%
With children of the householder under 18 years	1,291	2.6%	2.9%	1.6%	2.4%	2.5%	4.9%	1.9%	3.9%	8.0%	0.5%	1.5%	2.9%	4.3%	1.9%	0.0%
Male householder, no spouse/partner present	8,452	16.9%	16.2%	19.9%	25.7%	7.0%	20.0%	21.1%	23.8%	18.3%	9.3%	14.2%	17.3%	16.2%	14.0%	8.2%
Female householder, no spouse/partner present	11,901	23.8%	26.2%	17.7%	16.5%	27.6%	14.9%	32.0%	10.2%	26.1%	9.9%	20.2%	19.4%	25.6%	24.6%	31.5%
Households with one or more people under 18 years	14,088	28.2%	**31.4%**	26.9%	23.8%	**39.3%**	**43.7%**	24.8%	18.9%	**44.6%**	**36.3%**	**32.0%**	27.3%	**32.5%**	**30.0%**	17.8%
Households with one or more people 65 years +	17,145	34.3%	28.8%	**36.0%**	**48.1%**	28.1%	18.3%	**35.3%**	**38.4%**	**41.0%**	26.7%	32.6%	**36.0%**	33.4%	30.4%	**56.2%**
Male, living alone, with children of the householder under 18 years	593	1.2%	0.6%	0.4%	**4.4%**	0.0%	**4.4%**	2.3%	0.4%	**5.0%**	1.3%	0.0%	2.2%	**3.3%**	0.0%	0.0%
Female, living alone, with children of the householder under 18 yrs	1,604	3.2%	**4.3%**	2.1%	0.5%	**5.8%**	**3.9%**	2.3%	0.4%	**4.5%**	0.8%	**3.3%**	7.2%	**5.5%**	6.3%	0.0%
Male, living alone, 65 years and over	2,065	4.1%	3.6%	**6.7%**	**6.3%**	2.2%	0.0%	3.7%	1.4%	**5.4%**	2.3%	2.7%	3.6%	2.8%	1.1%	1.4%
Female, living alone, 65 years and over	3,631	7.3%	**7.5%**	**7.4%**	**10.2%**	2.2%	4.1%	**10.3%**	4.1%	**10.9%**	2.6%	4.2%	5.0%	**10.1%**	4.3%	6.8%

Source: U.S. Census Bureau, 2022 American Community Survey 5-year estimates

Households

Fifty-one percent of Linn County is comprised of married couple households. The second largest type of households are single adult households (male householders 16.9% and female householders 23.8%). Cohabitating couples comprise 7.8% of all households. Data about families and household structure may inform an understanding of who is vulnerable in the community. Table B-6 above presents data from the American Community Survey's 5-year estimates in 2022.

The proportion of households with individuals over 65 or under 18 may be relevant to an understanding of community vulnerability. In Linn County 28.2% of households include one or more people under 18 years and 34.3% of households include one or more people over the age of 65. Albany, Halsey, Harrisburg, Mill City, Millersburg, Scio, Sweet Home, and Tangent each have higher than the county average percentage of households including one or more children under 18.

Single parent households with one or more children are another type of household that may provide insight into vulnerability within a community. Within Linn County 1.2% of households are male single parent families and 3.2% of households are female single parent families. Cities with a higher proportion of single parent households than the county averages include Albany, Gates, Halsey, Harrisburg, Mill City, Scio, and Sweet Home. Harrisburg and Mill City have the greatest proportion of single parent households in the county ranging from 8.3% to 9.5% of households.

Individuals over the age of 65 living alone may represent the most vulnerable type of household. Women over the age of 65 living alone in Linn County averages 7.3% of households, while men over 65 living alone averages 4.1% of households in the county. Cities where the proportion of such households is greater than the county average include Albany, Brownsville, Gates, Lebanon, Mill City, and Sweet Home.

These populations will likely require additional support during a disaster and may place a strain on the emergency response effort if improperly managed.

Income

Research suggests that lack of wealth contributes to social vulnerability because individual and community resources are not as readily available. Affluent communities are more likely to have both the collective and individual capacity to more quickly rebound from a hazard event, while impoverished communities and individuals may not have this capacity – leading to increased vulnerability. Wealth can help those affected by hazard incidents to absorb the impacts of a disaster more easily. Conversely, poverty, at both an individual and community level, can drastically alter recovery time and quality.[7]

Household income and poverty status are indicators of economic capacity and the stability of the local economy. Household income can be used to compare economic areas as a whole but does not reflect how the income is divided among the area residents. Between 2010 and 2015 the share of households making less than $30,000 increased to 14% of households in Linn County, more than other income cohorts. Whereas, between 2015 and 2022, the share of households making less than $30,000 decreased to 7.3% of Linn County

[7] Cutter, S. L., et. al. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*.

households. In 2022, the highest income bracket, those households earning over $200,000 annually, had increased from 1% of households in 2015 to 5.2% of households.[8]

Table B-7, below, shows median household income in Linn County and its cities. These figures are not adjusted for inflation but are arranged in order from highest to lowest in 2022. The data allows comparison of the relative prosperity of households within the county in 2015 and 2022. Millersburg, Halsey, and Lyons had the highest median household incomes in 2022, while Harrisburg and Lebanon had the lowest median household incomes in 2022.

Table B-7. Median Household Income 2015 and 2022

	2015	2022
	Median Household Income	**Median Household Income**
Linn County	$45,644	$69,523
Millersburg	$72,778	$119,148
Halsey	$51,958	$96,250
Lyons	$60,417	$94,231
Brownsville	$48,158	$78,348
Waterloo	$64,722	$76,250
Scio	$49,531	$75,625
Mill City	$38,689	$73,625
Albany	$47,150	$69,777
Sweet Home	$35,076	$56,783
Tangent	$44,643	$53,985
Sodaville	$50,938	$53,958
Lebanon	$40,530	$53,246
Harrisburg	$48,125	$51,708

Source: 2022 ACS 5-yr estimates, Table S1901 and from 2017 Linn County MJ-NHMP source (Social Explorer, Table 57, U.S. Census Bureau, 2011-2015 American Community Survey Estimates)
Note: No adjustment for inflation.

Table B-8, below, identifies the percentage of individuals and cohort groups that were below the poverty level in 2022. The 2022 5-year American Community Survey estimated that about 12.0% of individuals (down from 19% of individuals in 2015), 13.6% of children under 18 (down from 28% in 2015), and 8.8% of those over 65 (about the same as 8% of seniors in 2015) live below the poverty level in Linn County. Sweet Home, Tangent, Sodaville, and Lebanon all have poverty rates above 14%. In Table B-8, red text indicates a higher poverty level than in 2015, green indicates a lower poverty level than in 2015, and blue indicates little change since 2015. Poverty rates have worsened for all cohorts within the City of Sodaville. In Halsey, Lyons, Sodaville, and Tangent, the percentage of people in poverty has worsened overall for those under 18 years old. Poverty for children has significantly worsened in Lyons, moving from 15% in 2015 to 39.2% in 2022. Poverty for children in Halsey more than doubled between 2015 and 2022. On the positive side,

[8] 2022 ACS 5-year estimates, Table S1901

poverty for children in Harrisburg has been reduced from 36% in 2015 to 14.3% in 2022, halved since 2015.

Poverty rates for those 65 years or older had worsened by 2022 in many cities in the county, whereas the overall countywide rate for this cohort has not changed much since 2015. Although childhood poverty rates in Harrisburg improved during this period, poverty among those 65 or older almost tripled since 2015. In Tangent the rate is more than four times greater in 2022 (22.4%) than in 2015 (5%). The poverty rate for those over 65 in Sweet Home doubled and in Scio it went from 0% in 2015 to 10.7% in 2022. Poverty rates for those over 65 improved in Mill City, Sodaville, and Waterloo.

Table B-8. Poverty Status in the Past 12 Months in Linn County and its Cities.

	Total population in poverty		Population under 18 years in poverty		Population 18 to 64 years in poverty		Population 65 years and over in poverty	
	Estimate	Percentage	Estimate	Percentage	Estimate	Percentage	Estimate	Percentage
Linn County	15,074	12.0%	3,623	13.6%	9,353	12.4%	2,098	8.8%
Albany	6,490	11.9%	1,987	15.3%	3,864	11.6%	639	7.5%
Brownsville	117	6.4%	8	2.0%	68	6.4%	41	10.8%
Gates	71	15.7%	28	33.3%	29	12.2%	14	10.8%
Halsey	116	8.3%	45	13.5%	58	6.4%	13	8.3%
Harrisburg	488	13.3%	164	14.3%	253	11.2%	71	26.3%
Lebanon	2,660	14.6%	419	11.1%	1,825	16.4%	416	12.6%
Lyons	160	13.6%	71	39.2%	78	11.4%	11	3.6%
Mill City	224	12.8%	59	11.7%	147	15.2%	18	6.4%
Millersburg	226	7.6%	87	10.3%	107	6.4%	32	7.1%
Scio	60	7.0%	15	6.9%	28	5.8%	17	10.7%
Sodaville	51	14.1%	13	19.7%	36	15.2%	2	3.4%
Sweet Home	1,676	17.4%	203	10.6%	1,176	19.6%	297	17.4%
Tangent	208	16.0%	54	20.8%	6	13.3%	48	22.4%
Waterloo	12	5.0%	0	0.0%	11	7.4%	1	1.7%

Source: US Census, 2022 American Community Survey 5-year estimates, Table S1701

Education

Educational attainment of community residents may influence social vulnerability and often reflects higher income. Educational attainment data reflects the regional economy and dominant employment sectors as they relate to potential employees for professional, service, and manual labor workforces. An oversaturation of either highly educated residents or low educational attainment can have negative effects on the resilience of the economy.

According to the U.S. Census 2022 5-year estimates from the American Community Survey, shown in Table B-9, below, almost 91% of the Linn County population over 25 years of age has graduated from high school or received a high school equivalency, with approximately 20.4% going on to earn a bachelor's and/or a graduate or professional degree.

In the City of Lebanon, the percentage of residents with less than a 9th grade education is slightly higher than the county average, however, the percentage of residents with a high school education is slightly above the county average. In the City of Mill City, the percentage of residents with less than a 9th grade education is more than double the county average,

while the percentage of residents with a high school education or equivalent is almost 6% greater than the county average. In Sodaville, the percentage of residents with less than a 9th grade education is also double the county average, while the percentage of residents with a high school education or equivalent is slightly above the county average. In the City of Millersburg, the percentage of residents with a graduate degree or higher and those with a bachelor's degree or greater are the greatest of any city in Linn County. Residents in Albany and Brownsville have also attained higher levels of education than many of the other cities in Linn County. In Table B-9, red text indicates a lower educational attainment than the County and green indicates higher educational attainment.

Table B-9. Educational Attainment in Linn County and its Cities

	Population 25 years and over	Less than 9th grade	9th to 12th grade, no diploma	High school graduate (includes equivalency)	Some college, no degree	Associate's degree	Bachelor's degree	Graduate or professional degree	High school graduate or higher	Bachelor's degree or higher
Linn County	89,890	2.6%	6.6%	29.5%	30.8%	10.2%	13.4%	7.0%	90.8%	20.4%
Albany	37,412	2.3%	5.0%	23.8%	29.9%	10.6%	18.8%	9.5%	92.7%	28.4%
Brownsville	1,343	0.0%	6.8%	28.8%	28.4%	10.8%	13.6%	11.6%	93.2%	25.2%
Gates	352	2.3%	6.5%	32.1%	30.7%	8.8%	17.0%	2.6%	91.2%	19.6%
Halsey	1,000	1.2%	2.7%	32.7%	46.7%	5.7%	9.4%	1.6%	96.1%	11.0%
Harrisburg	2,398	2.5%	8.2%	38.7%	29.4%	10.3%	7.3%	3.5%	89.3%	10.8%
Lebanon	12,772	3.0%	6.1%	31.9%	31.5%	7.2%	13.5%	6.8%	90.9%	20.2%
Lyons	918	1.2%	2.2%	28.6%	39.9%	12.4%	7.6%	8.1%	96.6%	15.7%
Mill City	1,130	6.7%	7.7%	35.7%	28.4%	11.3%	6.4%	3.8%	85.6%	10.2%
Millersburg	1,980	0.2%	4.8%	17.6%	35.8%	10.7%	15.2%	15.7%	94.9%	30.9%
Scio	592	4.7%	7.4%	29.4%	35.1%	14.7%	6.4%	2.2%	87.8%	8.6%
Sodaville	269	6.7%	8.6%	30.5%	31.2%	13.8%	7.4%	1.9%	84.8%	9.3%
Sweet Home	7,053	3.0%	16.3%	40.2%	23.5%	8.2%	6.8%	2.0%	80.6%	8.8%
Tangent	921	2.5%	8.6%	23.5%	32.8%	9.4%	15.7%	7.5%	88.9%	23.2%
Waterloo	197	1.0%	6.1%	36.0%	37.6%	9.1%	4.1%	6.1%	92.9%	10.2%

Source: US Census, 2022 5-year estimates, American Community Survey, Table S1501

Health and Housing Access

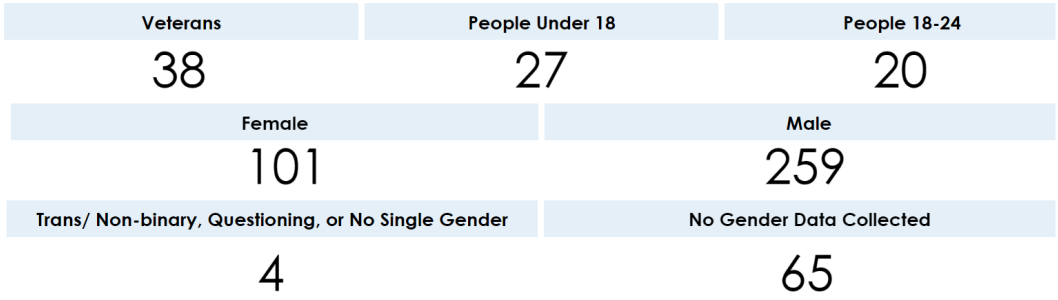
A resilient economy can consistently provide residents with basic needs, including shelter, safety, and food. Hospitals, clinics, and grocery stores are vital for preparing, responding, and recovering from a major disruption. High levels of baseline community health are important for resilience because communities with healthy residents are better able to absorb the impacts of, and recover from, disasters. Health insurance coverage is a positive indicator of community resilience.[9]

Health services are concentrated in Albany, Lebanon, and other larger communities in neighboring counties, but smaller communities to the north and east are still mostly within 15 miles of the nearest health care facility. Just under 8% of Linn County residents are uninsured, a slightly higher rate than the state at 7%.[10]

In 2023, Oregon Housing and Community Services (OHCS) conducted a point-in-time homeless count to identify the number of homeless and to characterize them demographically. The OHCS study found that 429 individuals in Linn County were homeless, up from187 individuals in 2015; 197 were sheltered and 232 were unsheltered, including [11]

Select Demographics of Homeless Individuals in Linn County, 2023

Figure B-8. Select Demographics of Homeless Individuals in Linn County, 2023



Source: Oregon Housing and Community Services, County Profiles 2023,

Summary

For planning purposes, it is essential to consider both immediate and long-term socio-demographic implications of hazard resilience. Immediate concerns include the growing elderly population and the high percentage of age-dependent populations (those who do not work because of being too young or too old). The current status of other social/demographic capacity indicators such as graduation rate, poverty level, householders living alone, and single-parent households can influence an individual's ability to respond and recovery from a disaster as well as the long-term impacts on the economy and stability of the community ultimately affecting future resilience.

Economic Profile

Economic capacity refers to the financial resources available and revenue generated in the community to achieve a higher quality of life. Income equality, housing affordability,

[9] University of Oregon, Institute for Policy Research and Engagement, Economic Resilience: Linn County
[10] Ibid.
[11] Oregon Housing and Community Services, County Profiles 2023, https://public.tableau.com/app/profile/oregon.housing.and.community.services/viz/CountyProfiles2023-OregonHousing/LandingPage

economic diversification, employment, and industry are measures of economic capacity. However, economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how the component parts of employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture.

Regional Affordability

The evaluation of regional affordability supplements the demographic resilience indicators. It is another analytical tool to understand the vulnerabilities of a community. This information can reflect the ability of individuals to prepare for hazards through actions such as retrofitting homes or purchasing insurance. If a community has high income inequality or is housing cost burdened, the potential for homeowners and renters to implement mitigation can be drastically reduced. Regional affordability metrics reflect the ability of community residents to get back on their feet without Federal, State or local assistance following a natural hazard event.

Income Equality

Income equality is a measure of the distribution of economic resources, as measured by income, across a population. It is a statistic defining the degree to which all people have a similar income. Table B-10, below, illustrates the county and cities level of income inequality. The Gini index is a measure of income inequality or the extent to which income is evenly distributed within a population. The index varies from zero to one. A value of one indicates perfect inequality, only one household has any income. A value of zero indicates perfect equality, all households have the same income.[12]

The cities within the county vary between 0.2832 and 0.4377, approximately the same range as reported in 2015. Cities where income varies the least and are the most equal are those with low GINI indexes, such as Halsey and Waterloo. Those cities with the greatest variation in income are those with higher GINI indexes, such as Lebanon and Tangent. Based on social science research, the cohesion of a region's response to a hazard event may be affected by the distribution of wealth in communities that have less income equality.[13]

[12]University of California Berkeley. Building Resilient Regions, Resilience Capacity Index. http://brr.berkeley.edu/rci/.

[13] Susan Cutter, Christopher G. Burton, and Christopher T. Emrich. 2010. "Disaster Resilience Indicators for Benchmarking Baseline Conditions," Journal of Homeland Security and Emergency Management 7, no.1: 1-22

Table B-10. Regional and Local Income Equality (GINI Index)

Jurisdiction	GINI coefficient
Linn County	0.4024
Halsey	0.2832
Waterloo	0.2988
Millersburg	0.3454
Scio	0.3489
Mill City	0.3602
Brownsville	0.3641
Gates	0.3761
Harrisburg	0.3823
Lyons	0.3867
Albany	0.3896
Sodaville	0.3916
Tangent	0.3964
Lebanon	0.4371
Sweet Home	0.4377

Source: US Census, American Community Survey, 2022 5-year estimates, Table B19083

Housing Affordability

The most commonly used measure of housing affordability is whether a household's housing costs are more than 30% of their income or not. Households spending 30% or more are considered housing cost burdened. Table B-11, below, displays the percentage of homeowners and renters reflecting housing cost burden across the region.

Linn County has a large percent of homeowners with a mortgage spending more than 30% of their income on housing (48%). Among renters, nearly 8,200 renters (51%) in Linn County pay more than 30% of their income on rent. In general, the population that spends more of their income on housing has proportionally fewer resources and less flexibility for spending in times of crisis. This disparity imposes challenges for a community recovering from a disaster as housing costs may exceed the ability of local residents to repair or move to a new location. These populations may live paycheck to paycheck and are extremely dependent on their employer. If their employer is also impacted, it will further the harm experienced by these individuals and families.

Table B-11. Household Spending >30% of Income on Housing

Jurisdiction	Owners				Renters	
	With Mortgage		Without Mortgage			
	Number	Percent	Number	Percent	Number	Percent
Linn County	**8,855**	**48%**	**2,175**	**21%**	**8,199**	**51%**
Albany	3,076	37%	690	20%	4,451	55%
Brownsville	145	49%	47	28%	61	45%
Halsey	**80**	**41%**	**0**	**0%**	**70**	**53%**
Harrisburg	**310**	**55%**	**94**	**32%**	**149**	**47%**
Lebanon	**1,290**	**53%**	**247**	**21%**	**1,566**	**54%**
Lyons	**97**	**45%**	**19**	**23%**	**41**	**35%**
Mill City	**210**	61%	**23**	21%	**117**	54%
Millersburg	**146**	43%	**20**	14%	**64**	55%
Scio	**88**	**51%**	**2**	**5%**	**39**	**50%**
Sodaville	**44**	**57%**	**2**	**10%**	**14**	**45%**
Sweet Home	**446**	45%	**138**	15%	**816**	58%
Tangent	**47**	**33%**	**48**	**40%**	**45**	**39%**
Waterloo	**19**	**40%**	**0**	**0%**	**3**	**23%**

Source: Social Explorer, Tables 103 and 109, U.S. Census Bureau, 2011-2015 American Community Survey Estimates

Economic Diversity

Economic diversity is a general indicator of an area's fitness for weathering difficult financial times. Business activity in the Willamette Valley region is homogeneous and consists mostly of small businesses. The Mid/Southern Willamette Valley Region Profile within the State Natural Hazards Mitigation Plan summarizes the current state of the area's economic environment.

Economic diversity is a general indicator of an area's fitness for weathering difficult financial times. One method for measuring economic diversity is through use of the Herfindahl Index, a formula that compares the composition of county and regional economies with those of states or the nation as a whole. Using the Herfindahl Index, a diversity ranking of 1 indicates the Oregon county with the most diverse economic activity compared to the state as a whole, while a ranking of 36 corresponds with the least diverse county economy. Table B-12, below, describes the Herfindahl Index Scores for counties in the region. It shows that, as of 2013, Linn County has an economic diversity rank of 4, this is on a scale between all 36 counties in the state where 1 is the most diverse economic county in Oregon and 36 is the least diverse.

Table B-12. Regional Herfindahl Index Scores

County	2008 Employment	2008 Number of Industries	2008 State Rank	2013 Employment	2013 Number of Industries	2013 State Rank
Benton	26,433	199	23	25,247	201	21
Lane	123,008	260	4	114,670	260	5
Lincoln	14,286	183	29	13,491	179	30
Linn	**36,360**	**225**	**5**	**33,934**	**222**	**4**
Marion	105,758	252	3	101,571	245	3
Polk	12,837	178	18	12,179	167	9
Yamhill	27,797	209	9	27,860	209	6

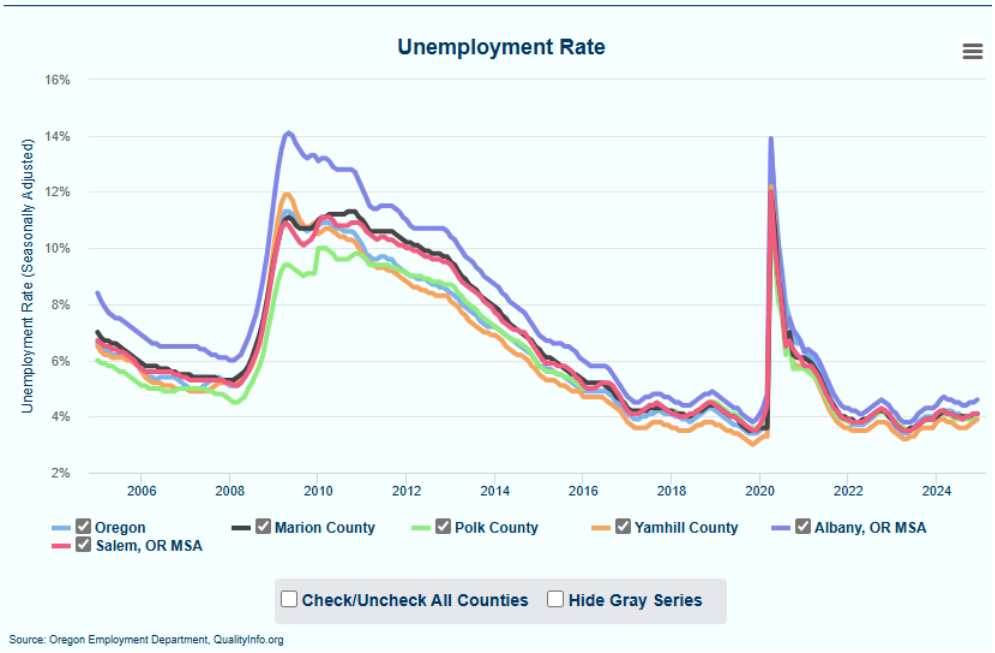
Source: Oregon Employment Department

While illustrative, economic diversity is not a guarantor of economic vitality or resilience. Linn County, as of 2025, is listed as an economically distressed community as prescribed by Oregon Law. The economic distress measure is based on indicators of decreasing new jobs, average wages and income, and is associated with an increase of unemployment.[14]

Employment and Wages

According to the Oregon Employment Department, unemployment in Linn County, and throughout Oregon, spiked in 2020 due to the impact of the COVID-19 pandemic. Since the end of 2021 the unemployment rate in the Albany Metropolitan Statistical Area (MSA) has risen and declined but has not exceeded 5% since August 2021.

Figure B-9. Unemployment Rate in the Mid-Willamette Valley, 2004-2024

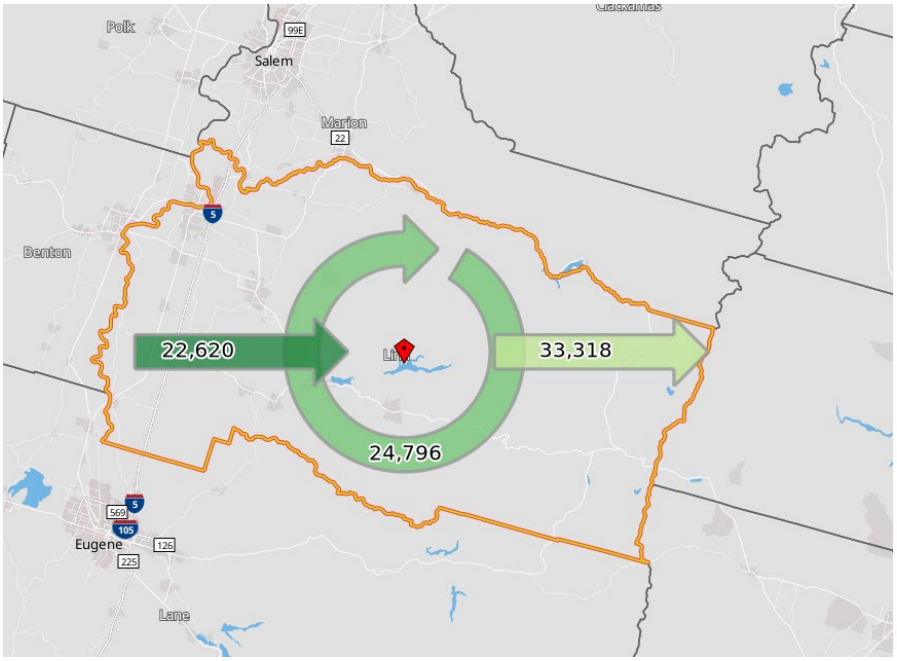


Source: Oregon Employment Department, https://www.qualityinfo.org/mid-valley.

[14] Business Oregon, Distressed Areas in Oregon, https://www.oregon.gov/biz/reports/Pages/DistressedAreas.aspx

Linn County's economy is a cornerstone of regional economic vitality. Linn County employers draw just under half of their workforce from outside the county. However, almost 60% of Linn County residents work outside of the county. Figure B-10 shows the county's labor-shed. In 2022, 47,416 workers were employed in Linn County, with 42.7% of workers living and working in the county (24,796), 47.7% of workers coming from outside the county (22,620), and 57.3% of residents working outside of the county (33,318).

Figure B-10. Linn County Labor-shed



Source: U.S. Census Bureau, Inflow/Outflow Job Counts in 2022, All Workers, https://onthemap.ces.census.gov/, accessed 12/2024.

Mitigation activities are needed at the business level to ensure the health and safety of workers and limit damage to industrial and other important infrastructure and community lifelines. Employees are highly mobile, commuting from all over the surrounding area to industrial and business centers. As daily transit rises, there is an increased risk that a natural hazard event will disrupt the travel plans of residents across the region and seriously hinder the ability of the economy to meet the needs of Linn County residents and businesses.

Industry

Major Regional Industry

Key industries are those that represent major employers and are significant revenue generators. Different industries face distinct vulnerabilities to natural hazards, as illustrated by the industry-specific discussions below. Identifying key industries in the region enables communities to target mitigation activities towards industry specific sensitivities.

It is important to recognize that the impact of a natural hazard event on one industry can reverberate throughout the regional economy. This is of specific concern when the businesses belong to the basic sector industry. Basic sector industries are those that are dependent on sales outside of the local community; they bring money into a local community via employment. The farm and ranch, information, and wholesale trade

industries are all examples of basic industries. Non-basic sector industries are those that are dependent on local sales for their business, such as retail trade, construction, and health services.

Employment by Industry

Economic resilience to natural disasters is particularly important for the major employment industries in the region. If these industries are negatively impacted by a natural hazard, such that employment is affected, the impact will be felt throughout the regional economy. Thus, understanding and addressing the sensitivities of these industries is a strategic way to increase the resiliency of the entire regional economy.

Although Linn County's total employment was flat for 2023, there were significant changes at the industry level. After gaining 410 jobs in 2022, Linn County's manufacturing sector added 220 jobs in 2023, growing 2.7%. With the recent employment gains, Linn County's manufacturing sector is 420 jobs below its pre-recession peak employment in 2019. Linn County's primary metals manufacturing sector added 300 jobs to grow 15.9% in 2023. Linn County's health care and social assistance sector showed employment growth in 2023; the sector added 200 jobs (+3.0%). In 2022 the sector was fairly flat, shedding 20 jobs (-0.3%).

The industry showing significant employment losses in 2023 was transportation, warehousing, and utilities. The industry's employment was down 460 or -11.3% in 2023 after gaining 70 jobs in 2022. The losses were concentrated in warehousing.

The other industry in Linn County's private sector that reported significant employment losses in 2023 was retail trade. The industry's employment was down 100 or -1.8% in 2023. That follows a fairly flat 2022, where retail trade lost 10 jobs.[15]

The US Census, ACS 5-year estimates indicate that there were approximately 61,706 individuals employed throughout the county with and the mean annual earnings for full-time year-round work was $62,828.[16] Most of the employed work either in *Trade, Transportation & Utilities*, *Manufacturing*, *Education and Health Services*, or *Local Government* occupations.

Table B-13, below, displays the occupation for the employed population 16-years and older in the Mid-Willamette Valley including Linn, Marion, Polk, and Yamhill Counties and projected change in employment by sector by 2032. Figure B-11, below, shows projected employment change in Linn and Benton Counties for the same period. Both sources indicate top areas of employment growth are projected to be Transportation, warehousing, and utilities; Private educational and health services; Leisure and hospitality; Government; Construction; and Professional and business services.

[15] Linn County - Year in Review 2023: Linn County - QualityInfo

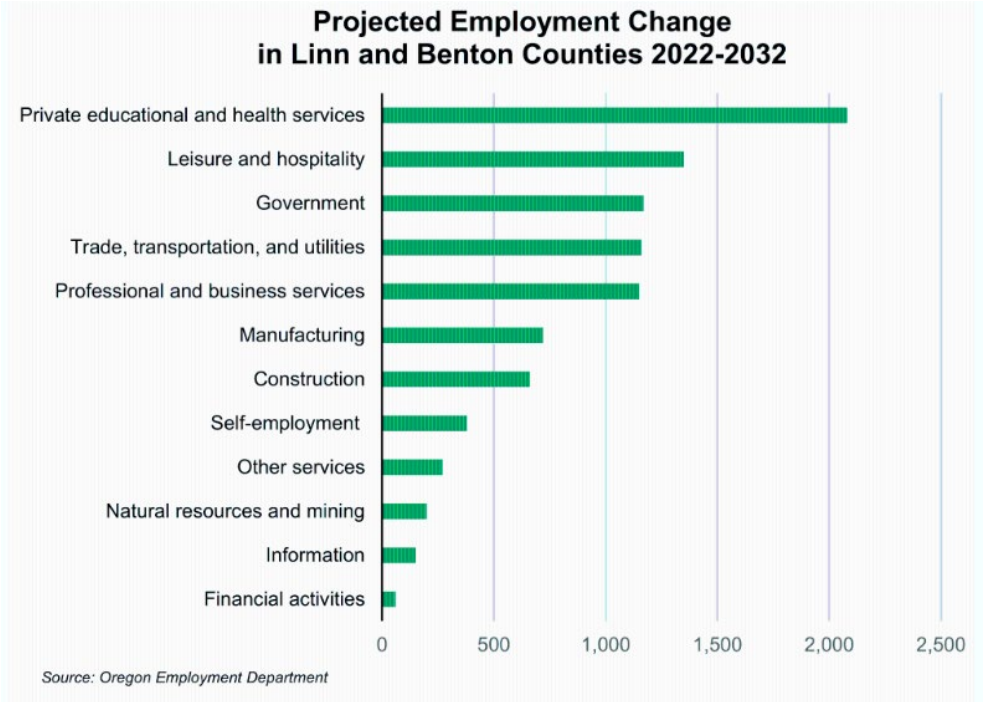
[16] US Census, 2022 5-year estimates and 1-year estimates, American Community Survey, Tables DP03 and S2001 respectively.

Table B-13. Mid-Willamette Valley Industry Employment Projections 2022-2032 for Linn, Marion, Polk, and Yamhill counties

	2022	2032	Change	% Change
Total employment	**297,600**	**326,400**	**28,800**	**10%**
Total payroll employment	277,500	304,900	27,400	10%
Total private	222,800	247,700	24,900	11%
Natural resources and mining	18,900	20,300	1,400	7%
Mining and logging	1,100	1,100	0	0%
Construction	**18,200**	**20,900**	**2,700**	**15%**
Manufacturing	26,900	28,600	1,700	6%
Trade, transportation, and utilities	46,200	50,300	4,100	9%
Wholesale trade	6,600	7,100	500	8%
Retail trade	28,200	28,900	700	2%
Transportation, warehousing, and utilities	**11,500**	**14,200**	**2,700**	**23%**
Information	2,200	2,500	300	14%
Financial activities	10,700	10,900	200	2%
Professional and business services	22,100	24,700	2,600	12%
Private educational and health services	**45,900**	**53,300**	**7,400**	**16%**
Leisure and hospitality	**23,000**	**26,800**	**3,800**	**17%**
Government	54,700	57,200	2,500	5%
Federal government	2,100	2,100	0	0%
State government	24,100	25,400	1,300	5%
Local government	28,500	29,700	1,200	4%
Self-employment	20,100	21,500	1,400	7%

Source: Oregon Employment Department, December 21, 2023, https://www.qualityinfo.org/documents/20126/110687/Mid-Valley+Industry+Employment+Projections+2022-2032/dd583dad-99f1-bdeb-a0b9-2547f29cacf5?version=1.11

Figure B-11. Projected Employment Change in Linn and Benton Counties, 2022-2032



Source: Oregon Employment Department, https://www.qualityinfo.org/-/2022-2032-employment-projections-in-linn-and-benton-counties

Job Growth and Economic Diversity

Diversified economies are more resilient. Regions that have a concentration of jobs in fewer industries are less resilient.

Linn County relies on both basic and non-basic sector industries. It is important to consider the effects each may have on the economy following a disaster. Basic sector businesses have a multiplier effect on a local economy that can spur the creation of new jobs, some of which may be non-basic. The presence of basic sector jobs can help speed the local recovery; however, if basic sector production is hampered by a natural hazard event, the multiplier effect could be experienced in reverse. In this case, a decrease in basic sector purchasing power results in lower profits and potential job losses for the non-basic businesses that are dependent on them.

Overall job growth in Linn County has outpaced job loss, with minimal loss of higher-wage industries, signaling a healthy job market. From 2010-2019, the construction industry dominated job growth in Linn County along with wood product and metal manufacturing industries. Jobs in these industries offer competitive wages to people with a mix of educational attainment levels.[17]

Fastest Growing Wages:

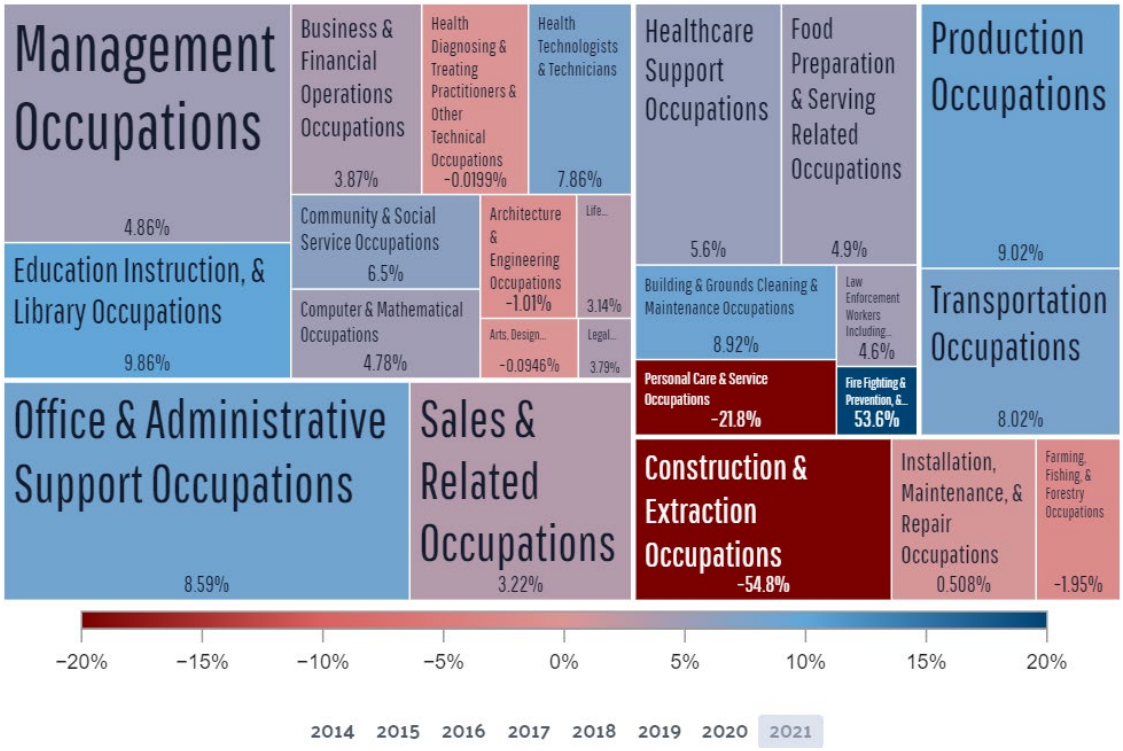
1. Construction $55,257
2. Wood product manufacturing $54,057
3. Primary metal manufacturing $85,141[18]

From 2020 to 2021, employment in Linn County, OR grew at a rate of 1.3%, from 56.3k employees to 57.1k employees.[19] The most common job groups, by number of people living in Linn County, are Office & Administrative Support Occupations (7,338 people), Management Occupations (5,634 people), and Production Occupations (4,387 people).[20] Figure B-12, below, illustrates the annual change in wages for primary jobs held by residents of Linn County.

Although the year between 2020 and 2021 was influenced by the economy's emergence from the effects of the COVID-19 pandemic on the workforce, there are several noteworthy changes as shown in Figure B-13, below. Notable from the perspective of this plan is the very high increase in mean annual earnings for Fire Fighting & Prevention and other Protective Service Workers. Wages in this sector rose 53.6% from 2020–2021, however the size of the workforce in this sector shrank by 17.8% during the same period. The number of people employed in the Personal Care & Service professions also shrank and the wages decreased by 21.8% from 2020-2021. The number of people employed in the Construction & Extraction Industry increased by 6.14%, however earnings decreased by 54.8% during this period.[21]

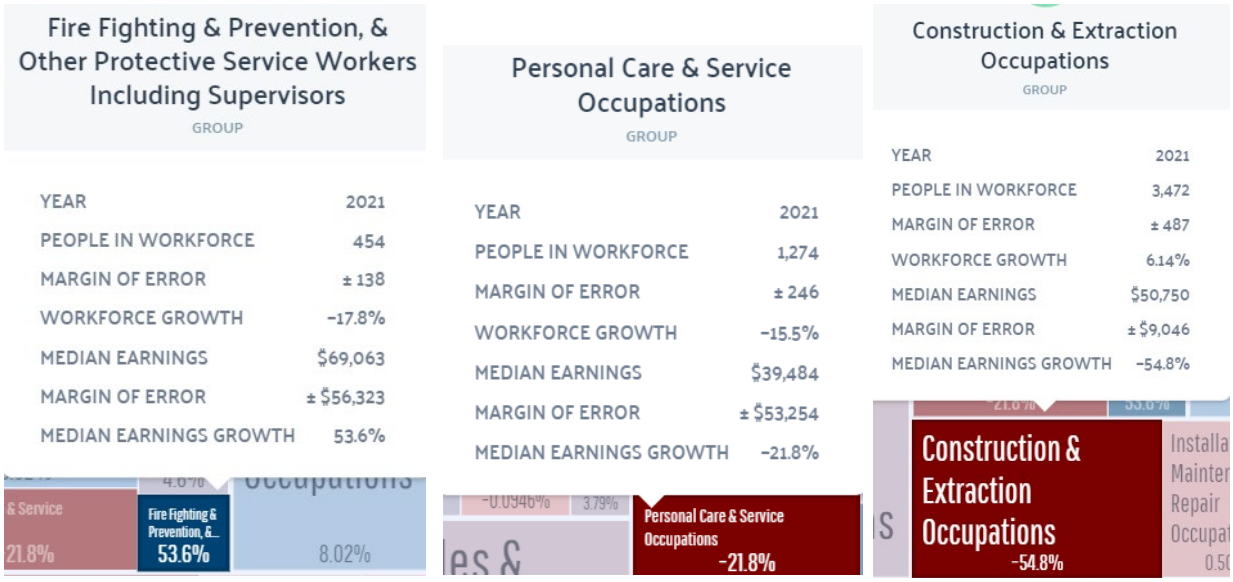
[17] University of Oregon, Institute for Policy Research and Engagement, Linn County Economic Resilience Profile.
[18] Ibid.
[19] Ibid.
[20] Ibid.
[21] Linn County, OR | Data USA

Figure B-12. Annual Change in Wages by Job Sector, 2020-2021



Source: [Linn County, OR | Data USA]

Figure B-13. Selected Detail for Change in Job Earnings by Sector



Source: [Linn County, OR | Data USA]

Summary

The current and anticipated financial conditions of a community are strong determinants of community resilience, as a strong and diverse economic base increases the ability of individuals, families, and the community to absorb disaster impacts for a quick recovery.

Strong signals of resilience in Linn County's Economic Profile include the following:

- Job growth in Linn County is outpacing job loss, and wages are competitive.
- Jobs are concentrated in specialized trades such as construction, wood product manufacturing, and primary metal manufacturing industries and depend on local, skilled labor.
- Projected population growth supports a growing local economy.[22]

Among the signals of less resilience within the Linn County economic profile is Linn County's older and less educated workforce as compared to the State of Oregon averages. This indicates some economic resilience risks related to employment diversity and earned wages.[23]

Because the major employers are key to post-disaster recovery efforts, the region is bolstered by its major employment sectors. It is important to consider what might happen to the economy if the largest revenue generators and employers are impacted by a disaster.

Built Environment Profile

The Built Environment Profile refers to the structures and infrastructure that support the community. The various forms, quantity, and quality of built capital contribute to community resilience. Physical infrastructure, including utility and transportation lifelines, are critical during a disaster and are essential for proper emergency operations and response. Lifelines are important structures that, when functioning during or immediately after an emergency, can enable a community to meet the health, safety, and economic needs of its residents. Lifelines provide fundamental services that can minimize direct and indirect consequences from a natural disaster and expedite the recovery process. Destroyed infrastructure or infrastructure in poor condition may limit access to services to meet a community's day-to-day needs, negatively affecting a community's ability to cope, respond, and recover from a natural disaster. Following a disaster, communities may experience isolation from surrounding cities and counties due to infrastructure failure. These conditions force communities to rely on local and immediately available resources.

Land Use and Development Patterns

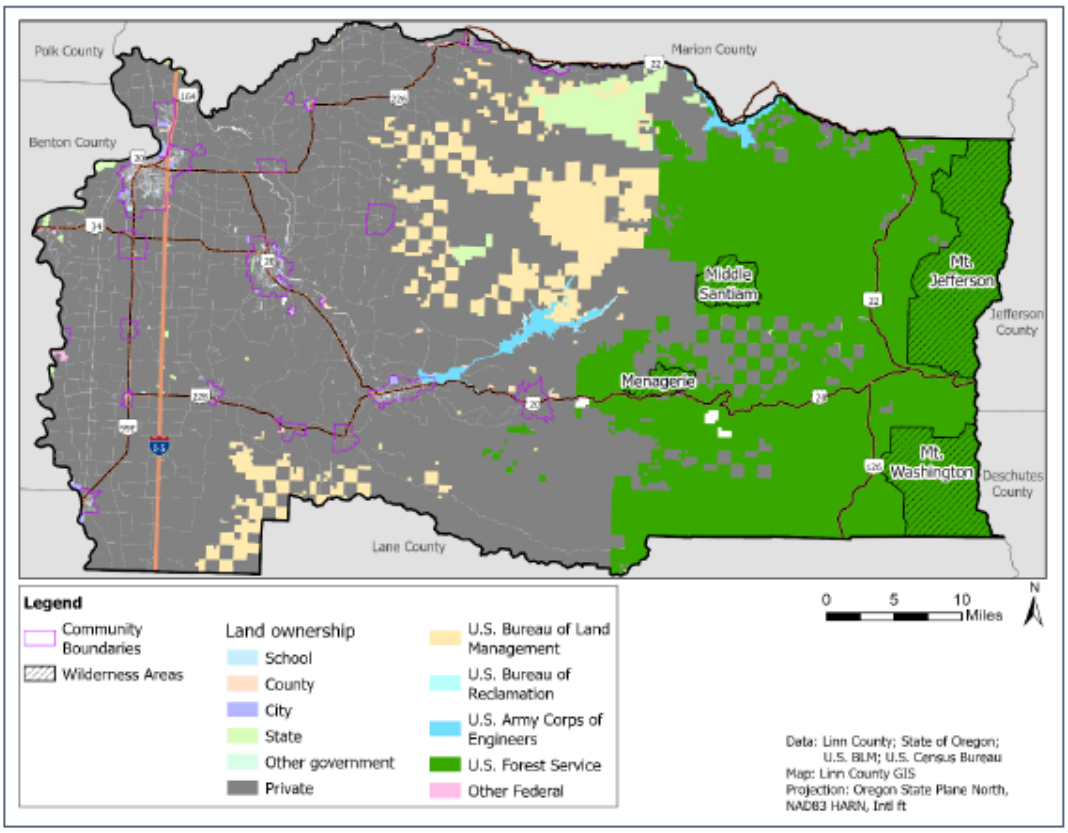
Linn County encompasses both the rich agricultural lands of the Willamette Valley and the productive forested mountainsides of the Cascade Range. Much of the area in the eastern portion of Linn County is classified as Forest Resource in the Linn County Comprehensive Plan with the majority of this in the Cascade Mountain Range. The topography, sparse population, and high precipitation of this region make it a prime location for forestry. Over 900,000 acres, nearly 65 percent of Linn County, is forested.[24] Much of the forested land is held in large-acre ownership with the Willamette National Forest managed by the U.S. Forest Service as one of the largest holdings. The Bureau of Land Management, U.S. Department of the Interior, administers lands under its jurisdiction.[25] Agricultural activity occurs throughout the valley region and in the foothills of the county. Between the

[22] University of Oregon, Institute for Policy Research and Engagement, Linn County Economic Resilience Profile.
[23] Ibid.
24 Linn County. "Land Use Element Code." 2024, https://www.linncountyor.gov/sites/default/files/fileattachments/planning_amp_building/page/2487/lcc_905_-_land_use_element_effective_10-15-24.pdf.
25 Ibid.

farmlands in the west and the mountainous forests in the east is an area that blends the character of the two major geographic regions of Linn County.

In the foothills of the Cascade Range, spanning from the northern to the southern border of the county are hilly lands with many streams. Rural residential development has occurred within these areas. These lands are designated Farm/Forest, a hybrid of the agricultural lands and the forestlands, and comprise approximately seven percent of Linn County. Land ownership is depicted in Figure B-14, below.

Figure B-14. Linn County Land Ownership Map

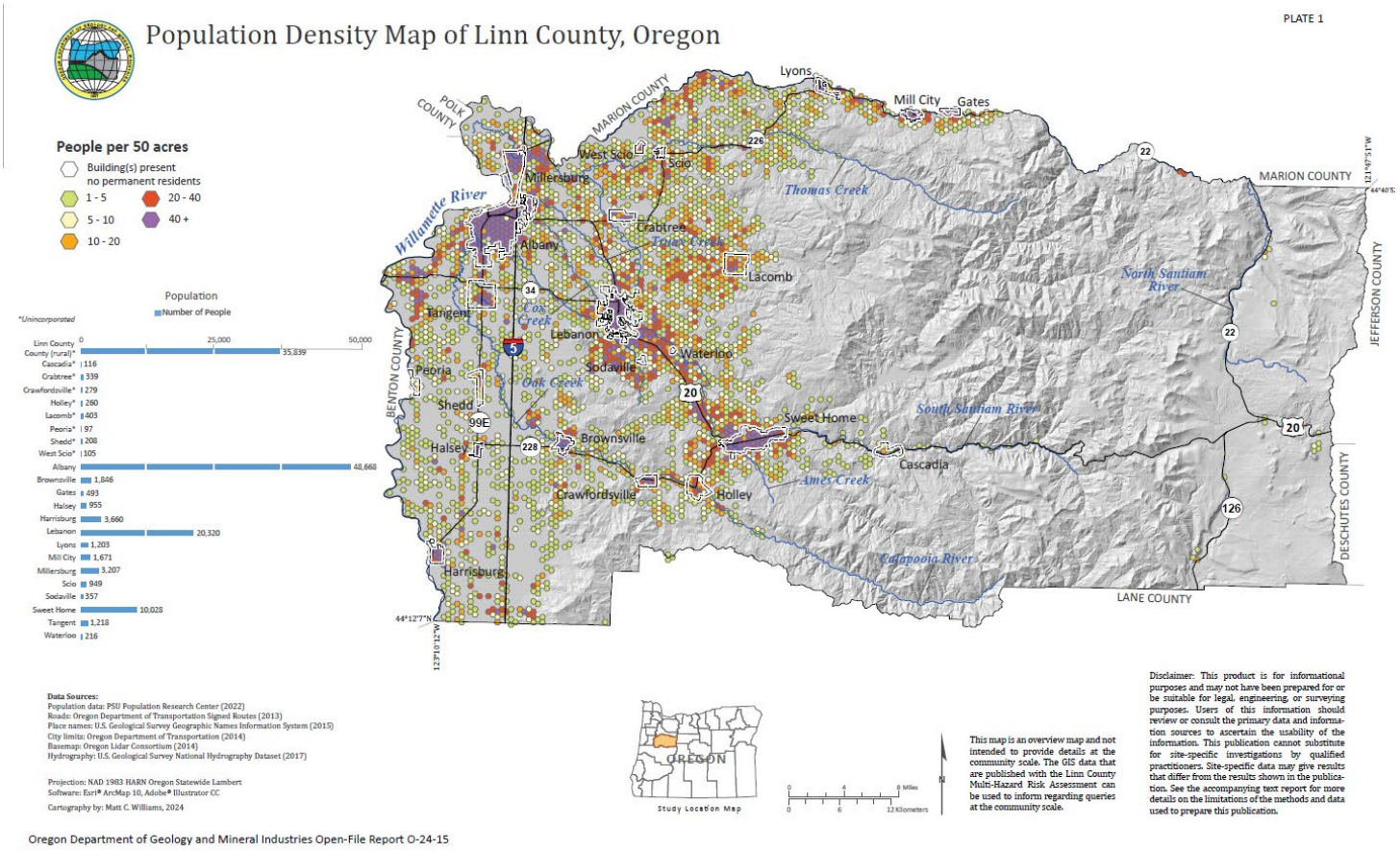


Source: Linn County Community Wildfire Protection Plan, 2024

Linn County is a large, predominately rural county characterized by a dispersed settlement pattern and three main population centers — Albany, Lebanon, and Sweet Home. Linn County consists of 15 incorporated cities (the cities of Albany, Gates, Idanha, and Mill City have portions in Benton or Marion County) and six unincorporated communities. Unincorporated communities are settlements located outside urban growth boundaries and include a mixture of land uses, specifically at least three commercial, industrial, or public land uses.[26] Locations of the cities and unincorporated communities in Linn County and population density are shown in the following figure.

[26] Land Conservation and Development Department. "Oregon Administrative Rules Compilation." 2003.

Figure B-15. Population Density Map of Linn County, Oregon



Source: DOGAMI Multi-hazard Risk Report, Linn County, Oregon

One significant way in which Linn County residents can increase or decrease their vulnerability to natural hazards is through development patterns. The way in which land is used – for example, a parking lot or maintained as an open space – will determine how closely the human-made systems of transportation, economy, etc., interact with the natural environment. All patterns of development, density as well as sprawl, bring separate sets of challenges for hazard mitigation.

Oregon's statewide land use planning program requires that incorporated cities and counties prepare and adopt comprehensive land use plans, zoning regulations, and land use permitting regulations. Urban growth boundaries (UGBs) were established under the program to manage growth so it occurs primarily in areas planned for urban use, while preserving farm and forest lands and limiting development in rural areas. UGBs around cities are required to contain enough land to meet estimated 20-year development needs based on employment and population growth estimates, and can be amended periodically to accommodate growth under certain conditions. Local and state policies currently direct growth away from rural lands and into UGBs, and, to a lesser extent, into rural communities. If development follows historical development trends, urban areas will expand their UGBs when needed to accommodate future projected growth, rural unincorporated communities will continue to grow, and overall rural residential density will increase slightly with the bulk of rural lands kept in farm and forest use, or even kept as open space. More information regarding Oregon's statewide land use planning program is included below in the Political and Regulatory Profile section of this Community Profile.

Changes in Development

Since the 2017 Linn County MJNHMP, the County has experienced growth in some of the urbanized parts of the county while other areas have seen only slight increases or have lost population. Between 2015 and 2023, there was a slight increase in county population overall (1.31% annualized change) while the unincorporated area of Linn County had a slight decrease in population (-0.09% annualized change of 29% of the county's population). The City of Millersburg experienced the highest population growth between 2015 and 2023 (13.52% annualized change of 2.4% of the county's population) followed by the City of Lebanon (4.17% annualized change of 15.4% of the county's population). Otherwise, incorporated communities in Linn County saw minimal growth (under 2% annualized change), including the City of Albany which has 36% of the county's population. Overall, more than 80% of the county's population lives within areas that saw less than 2% growth between 2015 and 2023. See Table B-1. Population Estimates, above, for further details.

While population growth has not increased dramatically, some development has taken place across the county, including residential, commercial, and public facilities. From 2018 through 2023, almost 700 building permits were issued by Linn County for new construction and for additions or alterations to existing structures. Residential development has outpaced commercial and public facilities development based on the numbers of permits issued. The following table provides a summary of building permits issued by type of development.

Table B-14. Linn County Issued Building Permits Summary

	Building Permits Issued		
Year	**Residential**	**Commercial**	**Public**
2018	75	26	8
2019	70	27	10
2020	89	33	1
2021	72	37	5
2022	82	40	2
2023	63	55	3
TOTAL	**451**	**218**	**29**

Source: Linn County Planning and Building Department

Certain natural hazards pose countywide impacts, including drought, earthquakes, extreme heat, smoke and poor air quality, windstorms/tornados, and winter storms. Other hazards are more place specific, like a river subject to flooding, landslides, volcanic lahar, or development in the WUI that is more exposed to wildfire.

Both Millersburg and Albany, the communities in the county that have seen the highest rates of population growth, are located in the western part of the county where the hazards of primary concern are earthquakes and floods. New construction in these communities must adhere to stringent seismic and floodplain development codes, helping to mitigate risk.

Flood hazards are predominantly located in the western part of the county along the Willamette River and its tributaries. As discussed in the risk assessment in Volume I, most areas with significant development in Linn County do not fall within the mapped floodplains. While Brownsville, Scio, and Tangent do have some areas that could be significantly impacted by flooding, growth in these communities since the last plan update has been

minimal. Overall, agricultural lands have suffered by far the most damage from flooding throughout the county. See the flood section of the risk assessment in Volume I for locations of the county's mapped flood hazard areas and more details regarding the location and extent of flood hazards.

Related to wildfire risk, the WUI in Linn County comprises 179 square miles, which is less than 8% of the overall area of the county (2,292 square miles). The communities with the largest acreages in the WUI receive fire protection services from the Lebanon, Scio, and Sweet Home fire districts, and are located at the eastern edge of the Willamette Valley into the foothills of the Cascade Mountains. New construction in Linn County since 2007 has contributed to an increase of area within the WUI. According to Linn County, at least 4,604 new structures for habitation have been built since 2007 in the county, with 3,896 of those being identified within the WUI.[27] See the wildfire section of the risk assessment in Volume I for locations of the county's WUI areas and more details regarding the location and extent of wildfire hazards.

An overall small increase in population growth and associated changes in development in areas most at risk have not necessitated major changes to community priorities except for wildfire. As noted above, there has been an increase in residential development in WUI areas resulting in greater exposure to wildfire. This updated analysis led to the inclusion of additional mitigation actions to address increased wildfire risk, based on the County's 2024 CWPP.

In general, Linn County and the cities do not currently have the capacity to analyze in detail how changes in development that have occurred intersect with the area's natural hazards to determine if development has occurred in or adjacent to hazard prone areas and if vulnerability has increased or decreased since the last NHMP. As such, a new mitigation action item, MH-15, has been included to identify a methodology and needed resources and to conduct an analysis of changes in development and impacts on vulnerability for the county and cities during the next NHMP update.

Housing

Mapping the location of housing relative to mapped hazards can help in implementing Statewide Planning Goal 7: Areas Subject to Natural Hazards and protecting people and property from damage due to natural hazard events. In particular, with respect to flooding, FEMA began assisting communities with floodplain mapping in the 1970's to help jurisdictions administer the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities are required by the NFIP to develop and implement floodplain management ordinances to protect people and property from flood loss and damage.

In addition to location, the characteristics of the housing stock affect the level of risk posed by some natural hazards. Table B-15, below, identifies the most common types of housing throughout Linn County. Of particular interest are mobile homes, which are particularly vulnerable to certain natural hazards, such as windstorms because they are more prone to wind damage than wood-frame construction. In other natural hazard events, such as earthquakes and floods, movable structures like mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants.

[27] Linn County Community Wildfire Protection Plan, 2024, https://www.linncountyor.gov/planningbuilding/page/community-wildfire-protection-plan.

Mobile homes account for almost 15% of the housing stock in Linn County. The highest percentage of mobile homes continue to be located in the cities of Tangent, Sodaville, and Waterloo. The City of Gates also has a high percentage of mobile homes and other mobile structures used as homes. This could be related to the 2020 Labor Day wildfires that devastated that city. In the City of Harrisburg, the percentage of mobile homes has increased more than in other cities where increases in this housing type are noted in red. There have been decreases in this type of housing within the cities of Lyons and Millersburg since 2015 as reported in the previous NHMP, denoted by green in Table B-15, below.

In addition to location and type of housing, the year structures were built has implications for resilience and safety from natural hazard events. The implementation of NFIP standards began in the 1970's. Seismic building standards were also codified via the Uniform Building Code starting in 1974; more rigorous building code standards were passed in the 1990's to better withstand potential damage from a Cascadia Subduction Zone earthquake. Therefore, homes built before the 1990's are more vulnerable to seismic events.

Figure B-16, below, illustrates the year residential structures were built in Linn County and its cities. The data was grouped into three categories: before 1970, between 1970 and 1989, and 1990 or after. The bars are arranged in decreasing order by percentage of homes built before 1970 with Linn County data at the bottom of the figure. Countywide, 33.7% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. About 62% (33.7% + 28.4%) of the housing stock was built before 1990 and the codification of seismic building standards. Nearly 38% of Linn County's housing stock was built after 1990.

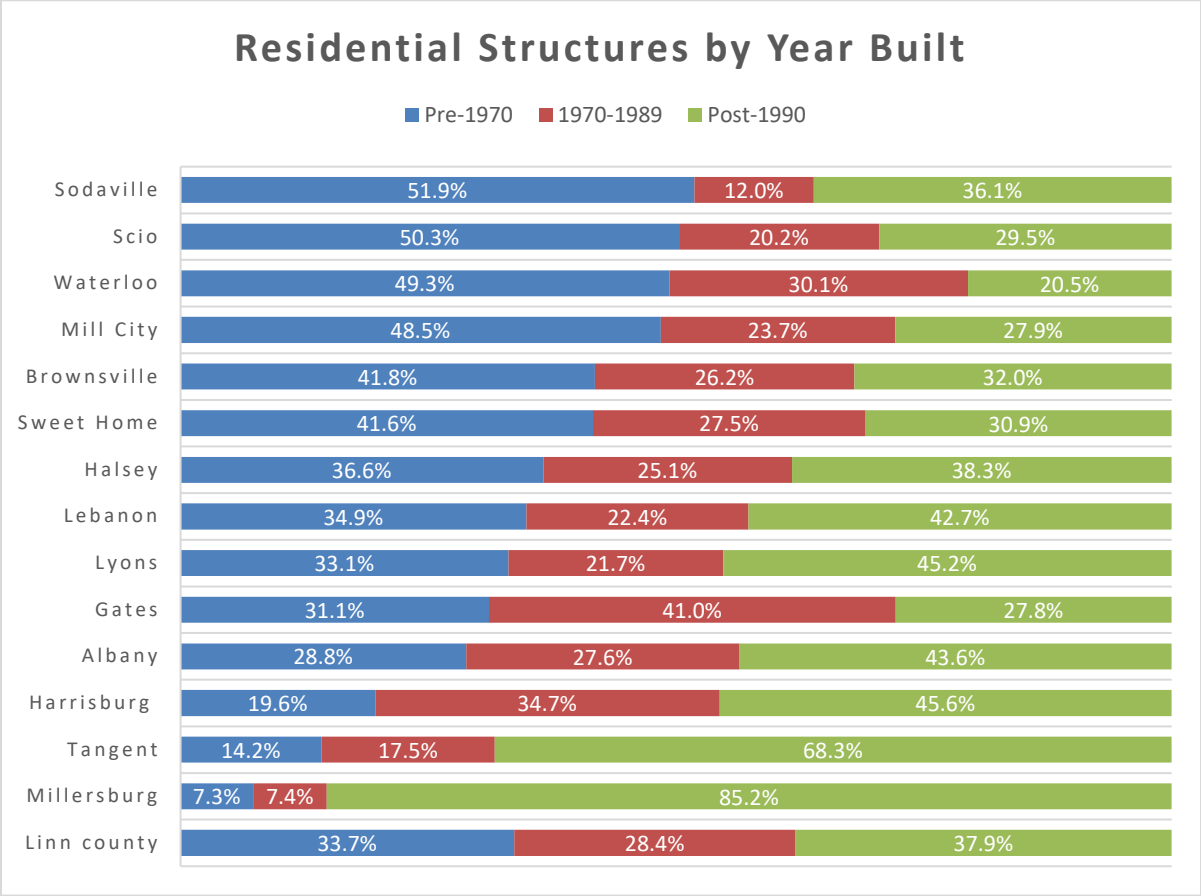
Among the cities in Linn County, Sodaville and Scio have the highest percentage of residential structures built before 1970 and are therefore potentially more vulnerable to damage from earthquakes. On the other end of the spectrum are Millersburg and Tangent with the smallest percentage of homes built before 1970. These cities also have the most recently built housing stock with 85.2% and 68.3% of homes, respectively, constructed in 1990 or after. These homes were constructed under more stringent seismic building codes and after NFIP standards for floodplain construction had been implemented.

Table B-15. Housing Occupancy and Structure Type

	Total Housing Units:	Occupied Units	Vacant Units	1-unit, detached	1-unit, attached	Percent Single Family Units*	2-9 units	10 or more units	Percent Multi-Family Units*	Mobile Home, Boat, RV, Van, etc.^	Percent Mobile Home*^
Linn County	52,145	49,944	2,201	32,370	2,188	69.2%	4,666	3,339	16.0%	7,381	14.8%
Albany	22,357	21,484	873	13,343	1,481	69.0%	3,251	2,055	24.7%	1,354	6.3%
Brownsville	825	774	51	661	0	85.4%	6	7	1.7%	100	12.9%
Gates	212	206	6	105	3	52.4%	11	0	5.3%	87	42.2%
Halsey	470	445	25	350	0	78.7%	15	7	4.9%	73	16.4%
Harrisburg	1,298	1,271	27	687	141	65.1%	62	89	11.9%	292	23.0%
Lebanon	7,718	7,458	260	4,399	477	65.4%	784	1,091	25.1%	707	9.5%
Lyons	526	508	18	428	6	85.4%	8	0	1.6%	66	13.0%
Mill City	710	597	113	478	8	81.4%	39	0	6.5%	72	12.1%
Millersburg	1,091	1,059	32	925	2	87.5%	3	0	0.3%	129	12.2%
Scio	346	331	15	245	7	76.1%	27	2	8.8%	50	15.1%
Sodaville	216	139	77	80	0	57.6%	0	6	4.3%	53	38.1%
Sweet Home	4,067	3,922	145	2,795	75	73.2%	400	43	11.3%	609	15.5%
Tangent	492	464	28	260	0	56.0%	9	0	1.9%	195	42.0%
Waterloo	73	73	0	50	0	68.5%	0	0	0.0%	23	31.5%

*Percentage of Occupied Units
^Also includes boats, RVs, vans, etc. that are used as a residence.
Source: US Census 2022 American Community Survey 5-year estimates, Table B25136

Figure B-16. Residential Structures by Year Built in Linn County and its Cities



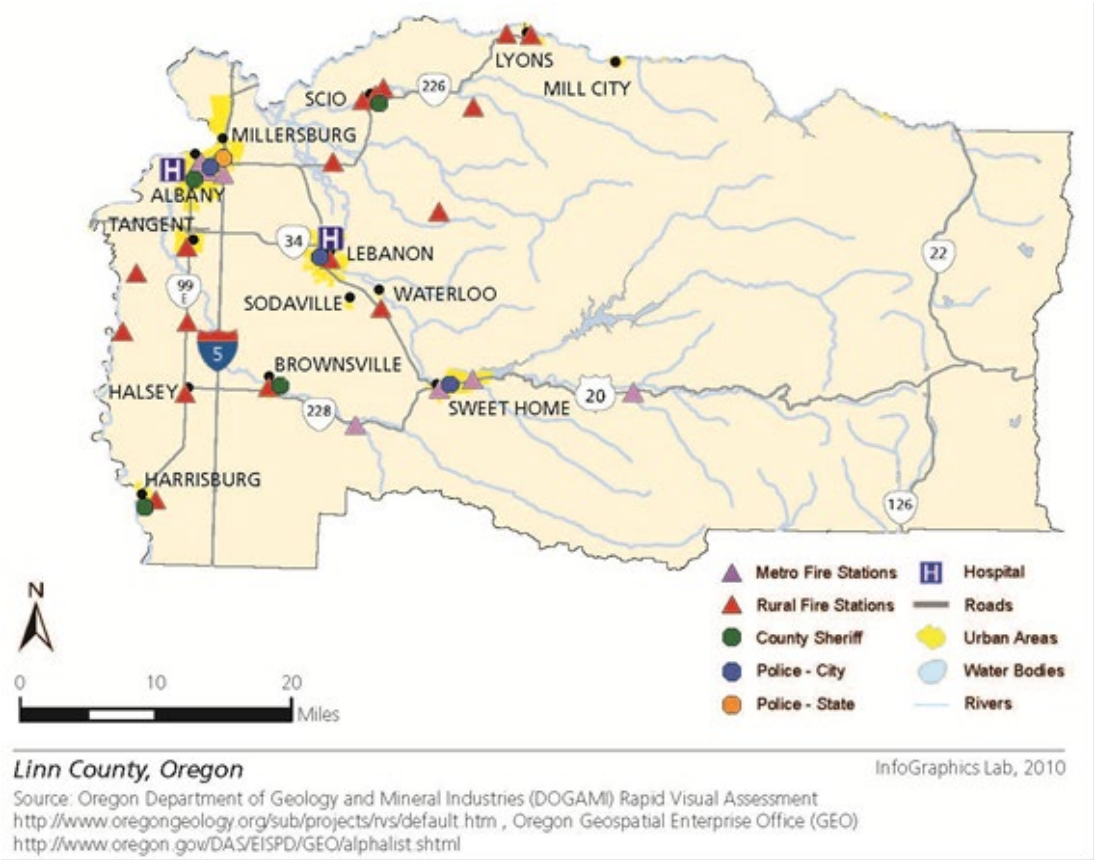
Source: US Census 2022 American Community Survey 5-year estimates, Table S2504

Critical and Essential Facilities

Critical facilities are those facilities that are essential to government response and recovery activities. These facilities include local police and fire stations, public works facilities, sewer and water facilities, hospitals, and shelters. The interruption or destruction of any of these facilities would have a debilitating effect on incident management. Essential facilities were defined more loosely for this NHMP update and include facilities that house social service uses, provide essential products and services to the public, or fulfill important public safety, emergency response, or disaster recovery functions.

Linn County has hospitals in Lebanon and Albany; local police stations in Albany, Lebanon, and Sweet Home; and fire and rescue facilities in Albany/Millersburg (city fire department, five stations, with one located in Benton County that also provides coverage to Linn County), Brownsville (two stations), Lebanon (five stations), Harrisburg (one station), Lyons (one station), Mill City (city fire department), and Sweet Home (four stations). There are six Rural Fire Protection Districts within the county (Scio RFPD, Lyons RFPD, Halsey-Shedd RFPD, Jefferson RFPD, Tangent RFD, and Gates RFPD).

Figure B-17. Linn County Critical Facilities



Other critical and necessary facilities vital to the efficient delivery of key governmental services, or that may significantly impact the public's ability to recover from emergencies, include correctional institutions, public services buildings, law enforcement centers, courthouses, and juvenile service buildings.

The following table lists Critical Facilities located within unincorporated Linn County. Lists of the Critical and Essential Facilities in each of the cities within Linn County can be found in Volume II: City and District Addenda.

Table B-16. Unincorporated Linn County (Rural) Critical Facilities by Type

Type	Facility Name	Community	Address
Fire	Brownsville RFD - Station 61	Brownsville	600 E Blakely Ave.
Fire	Halsey-Shedd RFPD - Station 52	Shedd	B St.
Fire	Halsey-Shedd RFPD - Station 53	Peoria	29399 Abraham Dr.
Fire	Halsey-Shedd RFPD - Station 54	Oakville	Oakville Rd.
Fire	Harrisburg Fire District Substation	Harrisburg	440 Smith St.
Fire	Lebanon Fire District - Station 32	Lacomb	E Lacomb Rd.
Fire	Lebanon Fire District - Station 33	Lebanon	Fairview Rd.
Fire	Lebanon Fire District - Station 35	Between Berlin & Powell	30797 Berlin Rd.
Fire	Lyons RFPD - Station 570	South of Jordan	39079 Jordan Rd.
Fire	Scio RFPD - Station 92	Crabtree	

Type	Facility Name	Community	Address
Fire	Scio RFPD - Station 93		43042 Burmester Dr.
Fire	Sweet Home Fire – Station 23	Crawfordsville	25995 1st St.
Fire	Sweet Home Fire – Station 24	Cascadia	49258 Santiam Hwy
School	Central Linn High School	East of Halsey	32433 Hwy 228
School	Clover Ridge Elementary School	NE of Albany, east of Millersburg	2953 Clover Ridge Rd NE
School	Crawfordsville Elementary School	Crawfordsville	38420 Glass Ave.
School	East Linn Christian Academy	Near Lebanon	36883 Victory Dr.
School	Hamilton Creek School	Near Lebanon	32135 Berlin Rd.
School	Harris Private School	Near Harrisburg	31414 Harris Dr.
School	Holley Elementary School	Holley	40336 Crawfordsville Dr.
School	Lake Creek Mennonite School	Near Peoria	26585 Peoria Rd.
School	Little Promises Children's Program	Near Sweet Home	28028 Pleasant Valley Rd.
School	Lourdes Public Charter School	Near Scio	39059 Jordan Rd.
School	Skyline Christian Academy		
School	Sweet Home Charter School	Liberty	28721 Liberty Rd.
Public Works	Brownsville STP	Brownsville	
Public Works	Halsey STP	Near Halsey	
Public Works	Harrisburg Water Facilities	Near Harrisburg	
Public Works	Lebanon Water Intake Facility	Near Lebanon	
Public Works	Scio Public Works shops	Near Scio	
Public Works	Scio STP	Near Scio	
Public Works	Tangent STP	Near Tangent	

Source: DOGAMI Multi-Hazard Risk Report, 2024, and NHMP update participants.

Infrastructure Profile

Physical infrastructure such as dams, levees, roads, bridges, railways, and airports support Linn County communities and economies. Transportation networks, systems for power transmission, and critical facilities such as hospitals and police stations, are all vital to the functioning of the region. Due to the fundamental role that infrastructure plays both pre- and post-disasters, it deserves special attention in the context of creating more resilient communities. The information documented in this section of the profile can provide the basis for informed decisions about how to reduce the vulnerability of Linn County's infrastructure to natural hazards. During an emergency, local transit systems can be shut down, affecting evacuations. In addition, roads that may become unusable from localized flooding and severe winter storms can potentially disrupt the daily driving routine of county residents. DOGAMI's Multi-Hazard Risk Report for Linn County (Appendix E) assesses the vulnerability of community lifelines, including bridges, communication infrastructure, fuel supply, food centers, financial institutions, and high-occupancy buildings, to several natural hazards.

Bridges and Highways

Because of earthquake risk, the seismic vulnerability of the county's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries

are unable to transport goods. The county's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities.

The bridges in Linn County require ongoing management and maintenance due to the age and types of bridges. Modern bridges, which require minimum maintenance and are designed to withstand earthquakes, consist of pre-stressed reinforced concrete structures set on deep steel piling foundations. DOGAMI's analysis of risks to Linn County bridges provides information regarding specific bridges and exposure to the following hazards: scour risk from flooding, liquefaction susceptibility, landslide susceptibility, channel migration, wildfire, and volcanic lahar. See Appendix C of the DOGAMI Multi-Hazard Risk Report for Linn County, included in Appendix E of this plan.

Bridge inspection is conducted by the ODOT, except for bridges less than 20 feet in length which are inspected by Linn County. All Linn County bridges are inspected at two-year intervals. Bridges that are found to be in critical condition during an inspection are prioritized for immediate replacement. Continued repair, maintenance, and widening of bridges will be necessary over the next 20 years. Linn County is working closely with ODOT to inventory and rank all the County's bridges with respect to earthquake response.

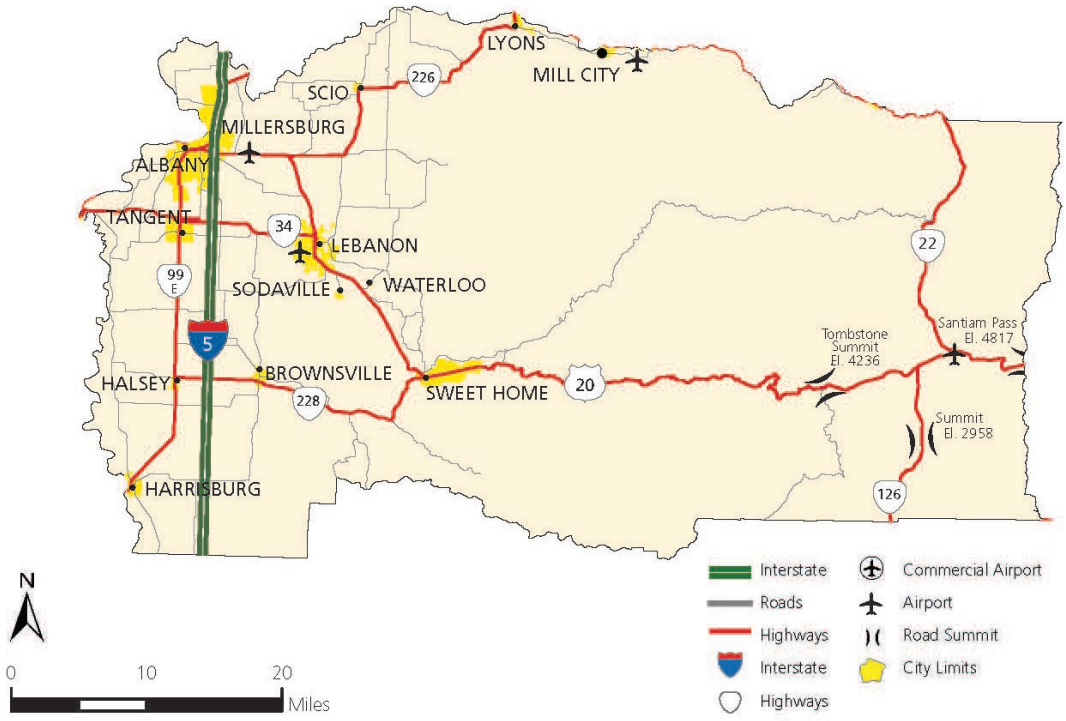
Three bridges in the county are considered too narrow. These are the Brownsville Bridge, the Scio Bridge, and the Mill City Bridge. Linn and Benton counties are separated by the Willamette River so there are no land connections between the two counties. There are only two bridge crossing points linking the two counties, comprised of five total bridges. Two are on Highway 20 in Albany and three are on Highway 34 at Corvallis.

The Van Buren Street Bridge linking Linn County and the City of Corvallis on Highway 34 was in need of improvement or replacement; it is currently being replaced with work starting in 2023. Damage to any of these crossings could impact the economies of the two counties. These inter-county routes may become strained with increased development and commuting traffic.

A well-developed network of local rural highways and county roads connects the Linn County communities to each other and to the region. Interstate 5 (I-5) is the major north-south freeway through Linn County and is the main route for vehicles traveling between Eugene and Portland and between Washington and California. Highway 99E runs parallel to I-5 and serves the communities of Harrisburg, Halsey, Shedd, Tangent, and Albany, as well as providing a backup route to the freeway. Other state highways serving Linn County include:

- US Route 20 -- Runs from Newport at the Oregon Coast east through Corvallis, Albany, Lebanon, and Sweet Home and then continues into and beyond eastern Oregon;
- State Highway 34 – Runs from Waldport at the Oregon Coast east through Corvallis, Albany and Lebanon;
- State Highway 226 – Runs from US Route 20 near Crabtree northeasterly through Scio and Lyons to Marion County;
- State Highway 228 – Runs from Halsey east across I-5 to Brownsville and Sweet Home; and
- State Highway 164 – Runs from I-5 North Millersburg exit 238 through Jefferson, previously considered as old Highway 99E.

Figure B-18. Linn County Transportation Routes



Linn County, Oregon
Source: Oregon Department of Transportation (ODOT)
http://www.oregon.gov/ODOT/

InfoGraphics Lab, 2010

Lifeline routes are critical transportation routes that are vital to continued public safety, mobility, and commerce in the event of a natural disaster. ODOT has identified state highways and important secondary lifeline routes in Linn County. The County designates ODOT lifeline routes in Linn County as Priority 1 routes. Priority 1 routes receive the highest priority for emergency road maintenance in the event of road closures.

The Linn County Road Department is divided into five maintenance districts. The lifeline route priority maps are organized by the maintenance district and show the emergency maintenance classification for Priority 1, Priority 2, and Priority 3 routes.

The major providers of public transportation include Linn-Benton Loop Bus, and Albany and Corvallis Transit Systems. Railroads and airports provide other modes of transportation in the county. Linn County is served by the Burlington Northern & Santa Fe, Union Pacific, Portland & Western, and Albany & Eastern railroads.[28] Facilities that support air travel include four public airports, 20 private airstrips, and one helipad.[29]

Dams

Dam failures can occur rapidly and with little warning. Fortunately, most failures result in minor damage and pose little or no risk to life safety. However, the potential for severe damage still exists. The Oregon Water and Resources Department has inventoried all dams

[28] Albany Transportation System Plan, 2009.
[29] Federal Aviation Administration, "Airport Facilities Data," Airport Data (5010) and Contact Information, http://www.faa.gov/airports_airtraffic/airports/, accessed February 2, 2010.

located in Oregon and Linn County. There are seven dams that are categorized as High Hazard.

Three of the High Hazard Potential Dams are owned and operated by the US Army Corps of Engineers. These are the Green Peter Reservoir Dam and the Foster Reservoir Dam, located on the Middle Santiam and the Santiam Rivers respectively, and the Detroit Dam, located on the North Santiam River along the Marion and Linn County border. Big Cliff Dam, located in Marion County downstream from the Detroit Dam on the North Santiam River, is also categorized as a High Hazard Potential Dam and owned and operated by the US Army Corps of Engineers.

Four High Hazard Potential Dams are not federally owned and include the following:

Dam Name	NID ID	Owner Names	Owner Types	Primary Purpose
Foster Log Pond	OR00159	Murphy Company Foster Veneer	Private	Other
Trail Bridge Saddle Dike	OR00540	Eugene Water and Electric Board	Public Utility	Hydroelectric
Smith	OR00541	Eugene Water and Electric Board	Public Utility	Hydroelectric
Trail Bridge	OR00540	Eugene Water and Electric Board	Public Utility	Hydroelectric

The Foster Log Pond dam, located within the city of Sweet Home, is adjacent to the Foster Dam and Foster Reservoir but is owned by a private company. The Smith Dam is located on the Smith River and is owned and operated by the Eugene Water and Electric Board (EWEB) to generate electricity; it is regulated by the Federal Energy Regulatory Commission (FERC). The Trail Bridge Dam and Trail Bridge Saddle Dike are located on the McKenzie River and are also owned and operated by EWEB to produce electricity and regulated by FERC.

Utility Lifelines

Utility lifelines are the resources that the public relies on daily, (i.e., electricity, fuel, and communication lines). If these lines fail or are disrupted, the essential functions of the community can become severely impaired. Utility lifelines are closely related to physical infrastructure, i.e., dams and power plants, as they transmit the power generated from these facilities.

The electric, oil, and gas lines that run through the Mid/Southern Willamette region are both municipally, cooperatively, and privately owned. A network of electricity transmission lines running through the Mid/Southern Willamette region allows Oregon utility companies to exchange electricity with other states and Canada. Most of the natural gas Oregon uses originates in Alberta, Canada. Northwest Natural receives natural gas via the Williams Company pipeline with a compressor station east of Albany. A petroleum pipeline originating in the Puget Sound transports liquid fuel – gas, diesel, and jet fuel – through the region and terminates in Eugene. These pipelines may be subject to failure secondary to corrosion if not properly monitored and maintained. Corrosion has also occurred resulting in failures secondary to unreported strikes on the pipelines during construction or other

activities, resulting in damage to protective coatings. These lines may also be vulnerable to severe, but infrequent natural hazards, such as earthquakes.[30]

Summary

Given the unique dependent, rural nature of Linn County, maintaining the quality of built capacity throughout the area is critical. The planning considerations seemingly most significant are contingency planning for medical resources and lifeline systems due to the imminent need for these resources. Functionality of hospitals and dependent care facilities are a significant priority in providing for Linn County residents. One factor that is critical to consider in planning is the availability of medical beds in local hospitals and dependent care facilities. In the event of a disaster, medical beds may be at a premium providing not just for the growing elderly population, but for the entire County. Other facilities to consider are utility lifelines and transportation lifelines such as airports, railways, roads, and bridges with surrounding counties to acquire utility service and infrastructure repair.

While these elements are traditionally recognized as part of response and recovery from a natural disaster, it is essential to start building relationships and establishing contractual agreements with entities that may be critical in supporting community resilience.

Community Connectivity Profile

Community connectivity places strong emphasis on social structure, trust, norms, and cultural resources within a community. In terms of community resilience, these emerging elements of social and cultural capital will be drawn upon to stabilize the recovery of the community. Social and cultural capitals are present in all communities; however, it may be dramatically different from one city to the next as these capitals reflect the specific needs and composition of the community residents.

Social Services and Community Networks

Social systems include community organizations and programs that provide social and community-based services for the public, such as employment, health, senior and disabled services, professional associations, and veterans' affairs. In planning for natural hazard mitigation, it is important to know what social systems exist within the community because of their existing connections to the public. Often, actions identified by the plan involve communicating with the public or specific subgroups within the population (e.g. elderly, children, low income, etc.). These services are more commonly located in urbanized areas of the county, however rural residents also need social services.

Linn County, cities, and special districts can use existing social systems as resources for implementing communication-related and other activities because these service providers already work directly with the public on several issues, one of which could be natural hazard preparedness and mitigation. Locally based community organizations may be important partners for implementing identified mitigation actions.

Three methods of public involvement were identified in the 2017 Linn County NHMP Community Profile and are listed below:

[30] 2020 Oregon Natural Hazards Mitigation Plan

- Education and outreach – organization could partner with the community to educate the public or provide outreach assistance on natural hazard preparedness and mitigation.
- Information dissemination – organization could partner with the community to provide hazard related information to target audiences.
- Plan/project implementation – organization may have plans and/or policies that may be used to implement mitigation activities, or the organization could serve as the coordinating or partner organization to implement mitigation actions.

Civic engagement may be an important indicator of community connectivity. Those who are more invested in their community may have a higher tendency to vote in political elections. Other indicators such as volunteerism, participation in formal community networks, and community charitable contributions are examples of other civic engagement that may increase community connectivity.

Cultural Resources

Historic Places

Historic and cultural resources such as historic structures and landmarks can help to define a community and may also be sources of community identity. Protecting these resources from the impact of disasters is important because they have an important role in defining and supporting the community. Overall, there are a total of 1,858 historically registered places in Linn County.

Linn County has nearly 70 structures on the National Register of Historic Places[31]:

- Aegerter, David and Maggie, Barn, Scio, Oregon
- Albany Custom Mill (Water Street Station), Albany, Oregon
- Albany Downtown Commercial Historic District, Albany, Oregon
- Albany Hebrew Cemetery, Albany, Oregon
- Albany Municipal Airport Historic District, Albany, Oregon
- Angell-- Brewster House, Lebanon, Oregon
- Archibald, Steven and Elizabeth, Farmstead (Archibald-Ropp Farmstead), Tangent, Oregon
- Barber, Granville H., House, Albany, Oregon
- Baker, Hiram, House, Lebanon, Oregon
- Booth, Dr. J.C., House, Lebanon, Oregon
- Boston Flour Mill (Thompson Flouring Mill), Shedd, Oregon
- Brown, Hugh Leeper, Barn, Brownsville, Oregon
- Brown, John and Amelia, Farmhouse (Atavista Farm), Brownsville, Oregon
- Cascadia Cave (35 LIN 11), Cascadia, Oregon
- Chamberlain, George Earle, House, Albany, Oregon
- Chambers, Matthew C., Barn, Albany, Oregon
- Cochran, William, Barn (Eggleston, Mattie and Wingo, Barn), Brownsville, Oregon
- Cooley, George C., House, Brownsville, Oregon
- Crabtree Creek—Hoffman Covered Bridge, north of Crabtree, Oregon
- Crandall, Louis A., House, Lebanon, Oregon
- Crawfordsville Bridge, Crawfordsville, Oregon

[31] Oregon Historic Sites Database, http://heritagedata.prd.state.or.us/historic/, accessed April 26, 2017

- Dawson, Alfred, House, Albany, Oregon
- Elkins Flour Mill, Lebanon, Oregon
- Fields, Hugh, House, Brownsville, Oregon
- First Baptist Church of Brownsville, Brownsville, Oregon
- First Evangelical Church of Albany, Albany, Oregon
- Flinn Block, Building, Albany, Oregon
- Hackleman Historic District, Albany, Oregon
- Hamilton, Joseph, Farm Group, Albany, Oregon
- Hannah Bridge, Scio, Oregon
- Harrisburg Odd Fellows Hall, Harrisburg, Oregon
- Hochstedler, George, House, Albany, Oregon
- Howe, C.J., Building, Brownsville, Oregon
- Independence Prairie Ranger Station, Willamette National Forest, Marion Forks, Oregon
- Larwood Bridge, east of Crabtree, Oregon
- Lebanon Pioneer Cemetery, Lebanon, Oregon
- Lebanon Southern Pacific Railroad Depot, Lebanon, Oregon
- Macpherson, Hector and Margaret, Barn, Albany, Oregon
- Maurer, Joseph and Barbar, House, Lebanon, Oregon
- Methodist Episcopal Church South (Bethesda Heritage Church), Albany, Oregon
- Milde, Gottlieb and Della, Barn, Brownsville, Oregon
- Monteith Historic District, Albany, Oregon
- Monteith, Thomas and Walter, House, Albany, Oregon
- Moore, John and Mary, House, Brownsville, Oregon
- Moyer, John M., House, Brownsville, Oregon
- Mt. Pleasant Presbyterian Church, Stayton, Oregon
- Parker, Moses, House, Albany, Oregon
- Perry, E.C., Building, Scio, Oregon
- Porter-Brasfield House, Shedd, Oregon
- Ralston, John and Lottie, Cottage, Lebanon, Oregon
- Ralston, John, House, Albany, Oregon
- Rock Hill School, Lebanon, Oregon
- Ross- - Averill House, Brownsville, Oregon
- Ryan, Michael and Mary, Barn, Scio, Oregon
- Short Bridge, Cascadia, Oregon
- Smith, James Alexander and Elmarion, Barn and Lame – Smith House, Halsey, Oregon
- St. Mary's Roman Catholic Church, Albany, Oregon
- Starr and Blakely Drug Store, Brownsville, Oregon
- Stellmacher, Gus and Emma, Farmstead, Tangent, Oregon
- Thomas Creek – Gilkey Covered Bridge, north of Crabtree, Oregon
- Thomas Creek – Shimanek Covered Bridge, east of Scio, Oregon
- United Presbyterian Church and Rectory, Albany, Oregon
- United Presbyterian Church of Shedd (Valley Rose Chapel), Shedd, Oregon
- Weddle Bridge, northwest of Crabtree, Oregon
- Wesely, Joseph, House and Barn, Scio, Oregon
- Wigle Cemetery, Harrisburg, Oregon
- Wigle, Abraham and Mary, House, Harrisburg, Oregon

- Wigle, Jacob and Maranda K., Farmstead, Brownsville, Oregon
- Z.C.B.J. Tolstoj Lodge No. 224, Scio, Oregon

Libraries and Museums

Libraries and museums develop cultural capacity and community connectivity as they are places of knowledge and recognition, they are common spaces for the community to gather and can serve critical functions in maintaining the sense of community during a disaster. They are recognized as safe places and reflect normalcy in times of distress. There are currently ten community libraries in Linn County located in Albany, Brownsville, Harrisburg, Lebanon, Lyons, Scio, and Sweet Home. There are approximately eleven museums in Linn County, which have an emphasis on the history and culture of the region.

Cultural Events

Elements of community connectivity are festivals and organizations that engage diverse cultural interests. An example of such an event in Linn County is the Northwest Art and Air Festival held in Albany. Not only does this event bring revenue into the community, but it also provides a venue for community connectivity while enhancing a sense of place. Cultural connectivity is important to community resilience, as people may be more inclined to help their neighbors in times of crisis when they feel part of the community.

Community Stability

Community stability is a measure of rootedness in a place. Resilience following a disaster may stem in part from familiarity with place. Familiarity with a place aids residents when navigating the community during and after a crisis and when residents seek services and other community support during economic or social challenges.[32] This was a factor in community resilience during and after the COVID-19 pandemic.

The table below estimated residential stability across Linn County in 2015. Geographic stability is calculated using the number of people who have lived in the same house and those who have moved within the same region (county) over the past year compared to the percentage of people who have migrated into the region. Linn County overall has geographic stability rating of about 93%, that is 93% of the population lived in the same house or moved within the county.

[32] Cutter, Susan, Christopher Burton, Christopher Emrich. “Disaster Resilience Indicators for Benchmarking Baseline Conditions”. Journal of Homeland Security and Emergency Management.

Table B-17. Regional Residential Stability

Jurisdiction	Population	Geographic Stability	Same House	Moved Within Same County
Linn County	**117,875**	**93%**	**83%**	**10%**
Albany	51,073	93%	79%	13%
Brownsville	1,548	93%	83%	10%
Halsey	**1,117**	**95%**	**81%**	**14%**
Harrisburg	**3,650**	**96%**	**93%**	**3%**
Lebanon	**15,733**	**92%**	**77%**	**15%**
Lyons	**1,150**	**95%**	**95%**	**0%**
Mill City	1,736	91%	85%	5%
Millersburg	1,658	95%	88%	7%
Scio	**817**	**93%**	**87%**	**5%**
Sodaville	**365**	**92%**	**90%**	**1%**
Sweet Home	9,086	90%	79%	11%
Tangent	**999**	**90%**	**86%**	**4%**
Waterloo	**264**	**99%**	**90%**	**9%**

Source: Social Explorer, Table 130, U.S. Census Bureau, 2011-2015 American Community Survey Estimates

Homeownership

Housing tenure describes whether residents rent or own the housing units they occupy. Homeowners are typically more financially stable but are at risk of greater property loss in a post-disaster situation. People may rent because they choose not to own, they do not have the financial resources for home ownership, or they are transient. The data in Table B-18, below, was retained from the 2017 NHMP.

Collectively, about two-thirds of the occupied housing units in Linn County were owner-occupied in 2015. Conversely, about one-third are renter occupied; Lebanon, Sweet Home, and Albany had the highest percentages of renter-occupied housing. Brownsville, Lyons, and Waterloo had the highest percentage of vacant housing units.

Table B-18. Housing Tenure and Vacancy

Jurisdiction	Total Occupied Units	Owner-occupied		Renter-occupied		Vacant^	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Linn County	45,100	28,988	64%	16,112	36%	3,329	7%
Albany	19,729	11,636	59%	8,093	41%	1,319	6%
Brownsville	598	463	77%	135	23%	100	14%
Halsey	389	257	66%	132	34%	21	5%
Harrisburg	1,174	857	73%	317	27%	76	6%
Lebanon	6,509	3,590	55%	2,919	45%	565	8%
Lyons	417	300	72%	117	28%	56	12%
Mill City	669	453	68%	216	32%	56	8%
Millersburg	592	476	80%	116	20%	40	6%
Scio	288	210	73%	78	27%	14	5%
Sodaville	129	98	76%	31	24%	9	7%
Sweet Home	3,335	1,928	58%	1,407	42%	190	5%
Tangent	380	264	69%	116	31%	23	6%
Waterloo	86	73	85%	13	15%	12	11%

Source: Social Explorer, Table 94, U.S. Census Bureau, 2011-2015 American Community Survey Estimates
^ Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

According to Cutter, wealth increases resiliency and recovery from disasters. Renters often do not have personal financial resources or insurance to assist them post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk of natural hazards.[33] In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable post-disaster.

Summary

Linn County has distinct social and cultural resources that work in the county's favor to increase community connectivity and resilience. Sustaining social and cultural resources, such as social services and cultural events, may be essential to preserving community cohesion and a sense of place. The presence of larger communities assist smaller rural communities with additional resources and services available for county and small-town residents. It is important to consider whether these amenities are equally distributed to the rural portions of the County and whether that distribution holds implications for recovery of less well served and vulnerable residents in the event of a disaster.

In the long-term, it may be of specific interest to Linn County to further evaluate community stability. A community experiencing instability may hinder the effectiveness of other beneficial social and cultural resources.

[33] Cutter, S. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*.

Political and Regulatory Profile

Political capacity is recognized as the government and planning structures established within the community. In terms of hazard resilience, it is essential for political capital to encompass diverse government and non-government entities in collaboration, as disaster losses stem from a predictable result of interactions between the physical environment, social and demographic characteristics, and the built environment.[34] Resilient political capital seeks to involve various stakeholders in hazard planning and works towards integrating a Natural Hazard Mitigation Plan with other community plans, so that all planning approaches are consistent.

Oregon's Regulatory Framework

Oregon land use planning laws require land outside Urban Growth Boundaries (UGBs) to be protected for farm, forest, and aggregate resource values. For the most part, this law limits the amount of development in rural areas. However, a land use designation can change from resource protection in one of two ways:

- The requested change could qualify as an exception to the Statewide Land Use Planning Goals, in which case the city must demonstrate to the State that the change meets requirements for an exception. These lands, known as exception lands, are predominantly designated for residential use.
- Resource land can also be converted to non-resource use when it can be demonstrated that the land is no longer suitable for farm or forest production.

Local and state policies currently direct growth away from rural lands into UGBs, and, to a lesser extent, into rural communities. If development follows historical development trends, urban areas will expand their UGBs, rural unincorporated communities will continue to grow, and overall rural residential density will increase slightly with the bulk of rural lands kept in farm and forest use. The existing pattern of development in the rural areas, that of radiating out from the urban areas along rivers and streams, is likely to continue. Most of the "easy to develop" land is already developed, in general leaving more constrained land such as land in the floodplains or on steep slopes to be developed in the future, perhaps increasing the rate at which development occurs in natural hazard areas.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of that program is a set of 19 statewide planning goals that express the state's policies on land use and related topics, such as community involvement, land use planning, natural resources, and areas subject to natural hazards.

Most of the goals are accompanied by "guidelines," which are suggestions about how a goal may be applied and some goals are implemented through State statute and rules. Oregon's statewide goals are achieved through local comprehensive planning. State law requires each city and county to adopt a comprehensive plan and the zoning and land-division ordinances needed to put the comprehensive plan into effect. A local comprehensive plan must be consistent with the statewide planning goals.

Periodic Review is a term used in Oregon law to describe the periodic evaluation and revision of a local comprehensive plan for consistency with the Statewide Land Use Planning Goals. Since 1981, state law (ORS 197.628 - 636) has called for cities and counties to review

[34] Mileti, D. 1999. Disaster by Design: a Reassessment of Natural Hazards in the United States. Washington D.C.: Joseph Henry Press.

their comprehensive plans according to a periodic schedule established by the Land Conservation and Development Commission (LCDC). When LCDC officially approved a local government's comprehensive plan, the plan was said to be "acknowledged," becoming the controlling document for land use in the area covered by that plan.

In 2007, the legislature revised the requirements of Periodic Review to include only those cities with a population greater than 10,000. Also, the legislature scaled back the requirements of Periodic Review to include only the fundamental building blocks of local planning. When changes to the comprehensive plan or the implementing ordinances are proposed by a city or county, a Post Acknowledgement Plan Amendment now takes the place of a full-scale consistency review.

Goal 7

The purpose of Goal 7: Areas Subject to Natural Hazards[35] is to "protect people and property from natural hazards." Goal 7 requires local governments to adopt comprehensive plans, including inventories, policies, and implementing measures, to reduce risk to people and property from certain natural hazards. The identified natural hazards a city or county must address include floods, landslides, earthquakes, tsunamis, coastal erosion, and wildfires. A city or county may also address other natural hazards not specifically identified in Goal 7.

To comply with Goal 7, local governments are required to respond to new hazard inventory information from federal or state agencies. The local government must evaluate the hazard risk and assess the:

a) frequency, severity, and location of the hazard;
b) effects of the hazard on existing and future development;
c) potential for development in the hazard area to increase the frequency and severity of the hazard; and
d) types and intensities of land uses to be allowed in the hazard area.

Local governments must adopt or amend comprehensive plan policies and implementing measures to avoid development in hazard areas where the risk cannot be mitigated. In addition, the siting of essential facilities, major structures, hazardous facilities, and special occupancy structures may be prohibited in hazard areas where the risk to public safety cannot be mitigated. The state recognizes compliance with Goal 7 for coastal and riverine flood hazards by adopting and implementing local floodplain regulations that meet the minimum National Flood Insurance Program NFIP requirements.

In adopting comprehensive plan policies and implementing measures for protection from natural hazards local governments should consider:

a) the benefits of maintaining natural hazard areas as open space, recreation, and other low density uses;
b) the beneficial effects that natural hazards can have on natural resources and the environment; and
c) the effects of development and mitigation measures in identified hazard areas on the management of natural resources.

Local governments can coordinate their land use plans and decisions with natural hazards and emergency preparedness, response, recovery, and mitigation programs. Given the

[35] Oregon Department of Land Conversation and Development, Goal 7: Areas Subject to Natural Hazards Overview, https://www.oregon.gov/lcd/op/pages/goal-7.aspx

numerous waterways, agricultural, and forest lands, special attention may be given to problems associated with riverbank erosion and potential for wildland urban interface fires.

Goal 7 guides local governments to give special attention to the following when developing implementation measures:

1. Give special attention to emergency access when considering development in identified hazard areas.
2. Consider including programs to manage stormwater runoff as a means to address flood and landslide hazards.
3. Consider non-regulatory approaches to help implement the goal, such as financial incentives and disincentives, public information, or using existing programs to retrofit, relocate, or acquire existing dwellings and structures at risk from natural disasters.
4. When reviewing development requests in high hazard areas, require site specific reports, appropriate for the level and type of hazards. Site specific reports should evaluate the risk to the site as well as the risk the proposed development may pose to other properties.
5. Consider measures that exceed the standards required within the National Flood Insurance Program.

Government Structure

Local governments and their departments can encourage natural hazard mitigation at the county level by integrating mitigation strategies into existing plans, policies, and programs. If mitigation strategies are successfully integrated, mitigation becomes part of a government's daily activities. This section describes Linn County's government departments that can be useful for hazards mitigation.

Linn County's governing jurisdiction includes all areas not governed by the Bureau of Land Management, Willamette National Forest, or State-owned land. Linn County residents elect three County Commissioners, an assessor, county clerk, district attorney, surveyor, sheriff, and treasurer. County government consists of the following departments.

Business Development: provides business planning and counseling, financial counseling, loan packaging, and financial assistance to local businesses. This department can provide information to local businesses about incorporating hazard mitigation into their business practices.

Circuit Court: provide fair and accessible justice services that protect the rights of individuals, preserve community welfare and inspire public confidence.

County Attorney: responsible for responding to legal issues of Linn County. Serves as a legal resource center for county departments and personnel.

Extension Services: The Linn County Office of the Oregon State University Extension Service provides research-based educational information and programs in agriculture, forestry, fire, 4-H/youth and Family and Community Development for the residents of Linn County. Extension services can assist in disseminating information about natural hazards mitigation to the public.

Fair & Expo Services: responsible for assuring the long-term viability of the Linn County Fairgrounds, presenting an exceptional Annual Fair which celebrates the heritage and diversity of Linn County, and providing year-round opportunities for facility usage. The Fair

and Expo Services department can incorporate mitigation activities into their buildings and operations to reduce the impact of hazards to the Linn County Fairgrounds.

GIS: Geographic Information System (GIS) is designed for developing, maintaining, analyzing and displaying digital spatial data. The GIS department can play a role in identifying areas vulnerable to natural hazards.

Health Services: responsible for providing health-related programs and services to residents of Linn County. Programs and services include alcohol, drug, and problem gambling prevention and treatment; Commission on Children and Families; Development Disabilities programs; Environmental Health programs; and Mental Health Services. Health Services can play a role in mitigation by informing the public about natural hazards that Linn County faces.

Justice Courts: responsible for carrying out legal processes regarding certain civil and criminal actions that arise outside the city limits of any municipality. Linn County Justice Courts are located in Lebanon and Sweet Home.

Juvenile: increase public safety by coaching youth and families to make positive choices through education, skill building, and community partnerships.

Law Library: legal research library serving citizens and legal professionals.

Museums: holds historical information representing all of Linn County.

Parks: responsible for maintaining or developing public recreational areas. This includes but is not limited to hiking trails, camping and swimming areas, boat access points, and other points of interest included in 22 county parks. Parks can be a partner in implementing mitigation action items to reduce the impact of hazards on local parks.

Planning and Building: responsible for planning and building tasks such as permitting, code enforcement, examination of plans and buildings, code violations, and implementation of the county comprehensive plan. Planning and building departments play an important role by creating and/or implementing policies related to hazards mitigation.

Roads: responsible for the maintenance of approximately 1,139 miles of roadway and 325 bridges, as well as hundreds of culverts and other minor structures. The road department can integrate action items related to mitigating hazards to road infrastructure.

Surveyor: responsible for providing the residents of Linn County with professional surveying expertise and advice. The Surveyor carries out the surveying duties required by the Oregon Revised Statutes.

Tax Collector: responsible for collecting property taxes from each property owner in Linn County.

Existing Plans and Policies

Communities often have existing plans and policies that guide and influence land use, land development, and population growth. Such existing plans and policies can include comprehensive plans, zoning ordinances, and technical reports or studies. Existing plans and policies may have support from local residents, businesses, and policy makers. Many land-

use, comprehensive, and strategic plans get updated regularly, and can adapt easily to changing conditions and needs.[36]

The Linn County MJ-NHMP includes a range of recommended action items that, when implemented, will reduce the county's vulnerability to natural hazards. Many of these recommendations are consistent with the goals and objectives of the county's existing plans and policies. Linking existing plans and policies to the NHMP helps identify what resources already exist that can be used to implement the action items identified in the Plan. Implementing the NHMP's action items through existing plans and policies increases their likelihood of being supported and getting updated and maximizes the county's resources.

The following is a list of active plans and policies in Linn County that are relevant to natural hazards mitigation:

Linn County Comprehensive Plan

Date of Most Recent Revision: 2016

Author/Owner: Linn County

Description: Provides a general path for the course of growth and development of Linn County. The Comprehensive Plan is charted by the map, goals, and policies of this Comprehensive Plan in conjunction with the comprehensive plans of the cities in Linn County.

Relationship to Natural Hazard Mitigation Planning: The Linn County Comprehensive Plan guides land use within the county. Goals of preserving resources and protecting life from hazards can be linked to action items that guide development to reduce the county's risk to natural hazards. Hazard mitigation can be linked to action items for how the County will implement Oregon Statewide Planning Goal 7 requirements.

Linn County Community Wildfire Protection Plan

Date of Most Recent Revision: 2024

Author/Owner: Linn County, with support from DLCD and ODF

Description: This plan describes Linn County's risk from wildfires as well as the specific steps that it will take to reduce that risk now and in the future. It is a Community Wildfire Protection Plan (CWPP), a collaborative effort to reduce the potential for future loss of life and property resulting from wildfire. This CWPP is intended to assist Linn County in reducing its risk from WUI wildfire hazards by identifying resources, information, and strategies for risk reduction. It will also help to guide and coordinate mitigation activities throughout the County.

Relationship to Natural Hazard Mitigation Planning: Action items contained within the CWPP\are efforts intended to mitigate losses from future wildfires.

[36] Burby, Raymond J., ed. 1998. Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities.

Linn County Floodplain Management Code

Date of Most Recent Revision: 2016

Author/Owner: Linn County

Description: Regulations which apply to all areas of special flood hazard within the jurisdiction of Linn County, except areas within incorporated cities.

Relationship to Natural Hazard Mitigation Planning: Provisions of the Floodplain Management Code are to promote public safety and welfare and minimize flood related losses.

Linn County Transportation Plan

Date of Most Recent Revision: 2017

Author/Owner: Linn County

Description: The Transportation Plan contains brief background descriptions of facilities and issues followed by the complete list of adopted County transportation policies. In addition, sections of the Plan list prioritize proposed transportation projects.

Relation to Natural Hazard Mitigation Planning: Transportation systems assist in evacuation and response in the event of a natural hazard. Action items in the County's NHMP that are aimed at making the County's transportation system more disaster resistant to reduce potential damage and risk can be linked to this Plan.

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APPENDIX C: ECONOMIC ANALYSIS OF NATURAL HAZARD MITIGATION PROJECTS

This appendix was developed by the Oregon Partnership for Disaster Resilience at the University of Oregon's Community Service Center. It has been reviewed and accepted by FEMA as a means of documenting how the prioritization of actions must include a special emphasis on the extent to which benefits are maximized according to a cost/benefit review of the proposed projects and their associated costs.

The appendix outlines three approaches for conducting economic analyses of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: the State Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan* (OEM, 2000), FEMA Publication 331, *Report on Costs and Benefits of Natural Hazard Mitigation*. This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how an economic analysis can be used to evaluate mitigation projects.

Why Evaluate Mitigation Strategies?

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred. Evaluating possible natural hazard mitigation activities provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, law enforcement, utilities, and schools. Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce "ripple-effects" throughout the community, greatly increasing the disaster's social and economic consequences.

While not easily accomplished, there is value from a public policy perspective in assessing the positive and negative impacts from mitigation activities, and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

Mitigation Strategy Economic Analyses Approaches

The approaches used to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into three general categories: benefit/cost

analysis, cost-effectiveness analysis and the STAPLE/E approach. The distinction between the three methods is outlined below.

Benefit/Cost Analysis

Benefit/cost analysis is a key mechanism used by the Oregon Department of Emergency Management (OEM), FEMA, and other state and federal agencies in evaluating hazard mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

Benefit/cost analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoiding future damages, and risk. In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented. A project must have a benefit/cost ratio greater than 1 (i.e., the net benefits will exceed the net costs) to be eligible for FEMA funding.

Cost-Effectiveness Analysis

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

Investing in Public Sector Mitigation Activities

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions which involve a diverse set of beneficiaries and non-market benefits.

Investing in Private Sector Mitigation Activities

Private sector mitigation projects may occur on the basis of one or two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or landowner, whether a private entity or a public agency, required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or

4. Evaluate the most feasible alternatives and initiate the most cost effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchases. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

STAPLE/E Approach

Considering detailed benefit/cost or cost-effectiveness analysis for every possible mitigation activity could be very time consuming and may not be practical. There are some alternate approaches for conducting a quick evaluation of the proposed mitigation activities which could be used to identify those mitigation activities that merit more detailed assessment. One of those methods is the STAPLE/E approach.

Using STAPLE/E criteria, mitigation activities can be evaluated quickly by steering committees in a synthetic fashion. This set of criteria requires the committee to assess the mitigation activities based on the Social, Technical, Administrative, Political, Legal, Economic and Environmental (STAPLE/E) constraints and opportunities of implementing the particular mitigation item in a community. The second chapter in FEMA's How-To Guide "Developing the Mitigation Plan – Identifying Mitigation Actions and Implementation Strategies" as well as the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process" outline some specific considerations in analyzing each aspect. The following are suggestions for how to examine each aspect of the STAPLE/E approach from the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process."

Social: Community development staff, local non-profit organizations, or a local planning board can help answer these questions.

- Is the proposed action socially acceptable to the community?
- Are there equity issues involved that would mean that one segment of the community is treated unfairly?
- Will the action cause social disruption?

Technical: The city or county public works staff, and building department staff can help answer these questions.

- Will the proposed action work?
- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?
- Is it the most useful action in light of other community goals?

Administrative: Elected officials or the city or county administrator, can help answer these questions.

- Can the community implement the action?
- Is there someone to coordinate and lead the effort?

- Is there sufficient funding, staff, and technical support available?
- Are there ongoing administrative requirements that need to be met?

Political: Consult the mayor, city council or county board of commissioners, city or county administrator, and local planning commissions to help answer these questions.

- Is the action politically acceptable?
- Is there public support both to implement and to maintain the project?

Legal: Include legal counsel, land use planners, risk managers, and city council or county planning commission members, among others, in this discussion.

- Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity?
- Are there legal side effects? Could the activity be construed as a taking?
- Is the proposed action allowed by the comprehensive plan, or must the comprehensive plan be amended to allow the proposed action?
- Will the community be liable for action or lack of action?
- Will the activity be challenged?

Economic: Community economic development staff, civil engineers, building department staff, and the assessor's office can help answer these questions.

- What are the costs and benefits of this action?
- Do the benefits exceed the costs?
- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private?)
- How will this action affect the fiscal capability of the community?
- What burden will this action place on the tax base or local economy?
- What are the budget and revenue effects of this activity?
- Does the action contribute to other community goals, such as capital improvements or economic development?
- What benefits will the action provide? (This can include dollar amount of damages prevented, number of homes protected, credit under the CRS, potential for funding under the HMGP or the FMA program, etc.)

Environmental: Watershed councils, environmental groups, land use planners and natural resource managers can help answer these questions.

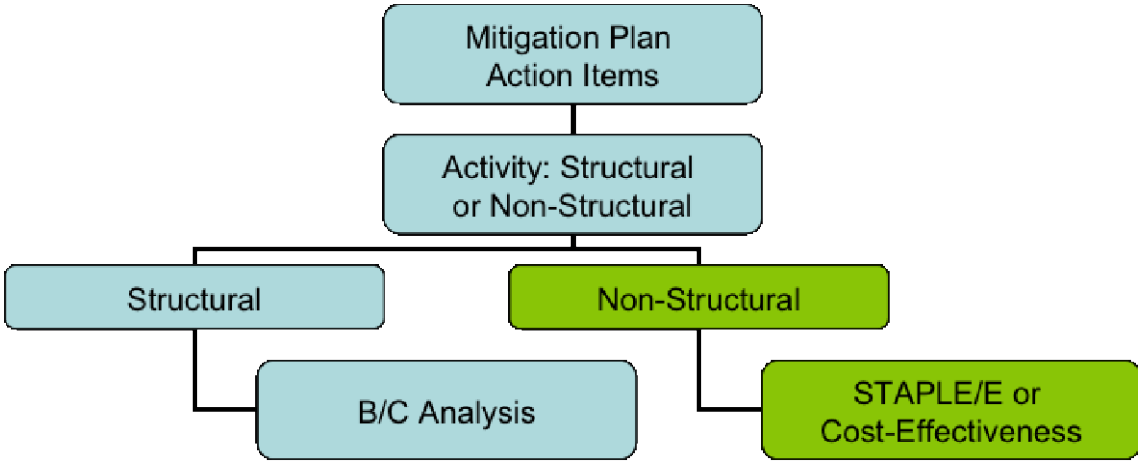
- How will the action impact or enhance the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

The STAPLE/E approach is helpful for doing a quick analysis of mitigation projects. Most projects that seek federal funding and others often require more detailed benefit/cost analyses.

When to Use the Various Approaches

It is important to realize that various funding sources require different types of economic analyses. The following figure is to serve as a guideline for when to use the various approaches.

Figure C-1. Economic Analysis Flowchart



Source: Oregon Partnership for Disaster Resilience. 2005.

Implementing the Approaches

Benefit/cost analysis, cost-effectiveness analysis, and the STAPLE/E are important tools in evaluating whether or not to implement a mitigation activity. A framework for evaluating mitigation activities is outlined below. This framework should be used in further analyzing the feasibility of prioritized mitigation activities.

1. Identify the Activities

Activities for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation projects can assist in minimizing risk to natural hazards, but do so at varying economic costs.

2. Calculate the Costs and Benefits

Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate activities. Potential economic criteria to evaluate alternatives include:

- ***Determine the project cost***. This may include initial project development costs, and repair and operating costs of maintaining projects over time.

- ***Estimate the benefits***. Projecting the benefits, or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.

- ***Consider costs and benefits to society and the environment***. These are not easily measured, but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.

- ***Determine the correct discount rate***. Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Activities

Once costs and benefits have been quantified, economic analysis tools can rank the possible mitigation activities. Two methods for determining the best activities given varying costs and benefits include net present value and internal rate of return.

- ***Net present value***. Net present value is the value of the expected future returns of an investment minus the value of the expected future cost expressed in today's dollars. If the net present value is greater than the projected costs, the project may be determined feasible for implementation. Selecting the discount rate, and identifying the present and future costs and benefits of the project calculates the net present value of projects.

- ***Internal rate of return***. Using the internal rate of return method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project. Once the mitigation projects are ranked on the basis of economic criteria, decision-makers can consider other factors, such as risk, project effectiveness, and economic, environmental, and social returns in choosing the appropriate project for implementation.

Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or landowners as a result of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and

prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, and small business development, among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

Resources

CUREe Kajima Project, *Methodologies for Evaluating the Socio-Economic Consequences of Large Earthquakes*, Task 7.2 Economic Impact Analysis, Prepared by University of California, Berkeley Team, Robert A. Olson, VSP Associates, Team Leader; John M. Eidinger, G&E Engineering Systems; Kenneth A. Goettel, Goettel and Associates, Inc.; and Gerald L. Horner, Hazard Mitigation Economics Inc., 1997

Federal Emergency Management Agency, *Benefit/Cost Analysis of Hazard Mitigation* Projects, Riverine Flood, Version 1.05, Hazard Mitigation Economics, Inc., 1996

Federal Emergency Management Agency, *Report on the Costs and Benefits of Natural Hazard Mitigation*. Publication 331, 1996.

Goettel & Horner Inc., *Earthquake Risk Analysis Volume III: The Economic Feasibility of Seismic Rehabilitation of Buildings in the City of Portland*, Submitted to the Bureau of Buildings, City of Portland, August 30, 1995.

Goettel & Horner Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects* Volume V, Earthquakes, Prepared for FEMA's Hazard Mitigation Branch, Ocbober 25, 1995.

Horner, Gerald, *Benefit/Cost Methodologies for Use in Evaluating the Cost Effectiveness of Proposed Hazard Mitigation Measures*, Robert Olsen Associates, Prepared for Oregon Military Department – Office of Emergency Management, July 1999.

Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, 2000.)

Risk Management Solutions, Inc., *Development of a Standardized Earthquake Loss Estimation Methodology*, National Institute of Building Sciences, Volume I and II, 1994.

VSP Associates, Inc., *A Benefit/Cost Model for the Seismic Rehabilitation of Buildings*, Volumes 1 & 2, Federal Emergency management Agency, FEMA Publication Numbers 227 and 228, 1991.

VSP Associates, Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects: Section 404 Hazard Mitigation Program and Section 406 Public Assistance Program, Volume 3: Seismic Hazard Mitigation Projects*, 1993.

VSP Associates, Inc., *Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model*, Volume 1, Federal Emergency Management Agency, FEMA Publication Number 255, 1994.

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APPENDIX D:
GRANT PROGRAMS AND RESOURCES

Grant Programs and Resources

There are numerous local, state, and federal funding sources available to support natural hazard mitigation projects and planning. The following section includes an abbreviated list of the most common funding sources utilized by local jurisdictions in Oregon. Because grant programs often change, it is important to periodically review available funding sources for current guidelines, program descriptions, and updated deadlines.

Local

Local funding depends on the funding mechanisms your jurisdiction has authority to use. A few common types of funding for hazard mitigation projects include:

Capital Improvement Project (CIP)

Many jurisdictions put together a set of their big-ticket items into a budget package called a CIP budget or 'Capital Projects' budget. These projects usually have been on the organizational 'to do' list for some time or have gained priority status through another mechanism such as a planning, design, or strategic planning process. Once a project moves into this status, an array of budget tools are deployed.

Deferred and Lifetime Maintenance Funding

Other considerations about how to use lines of funding essentially amount to either a future line of funding or a deficit (such as an unfunded mandate or deferred maintenance). Lifetime Maintenance funding is a component of a project that can be included in a CIP or other project budget. This includes the expected operations and maintenance (O&M) costs of the project, and it rolls those costs into the upfront costs so there is a budget available for them. The alternative to this is a piece of equipment or other asset that does not receive the maintenance it needs due to budget cuts, which then has a shorter life and thus a higher annual cost to the jurisdiction and its customers.

General Obligation Bond

A general obligation bond (GO bond) is a municipal bond backed solely by the credit and taxing power of the issuing jurisdiction rather than the revenue from a given project. General obligation bonds are issued with the belief that a municipality will be able to repay its debt obligation through taxation or revenue from projects. No assets are used as collateral. In Oregon Revised Statutes, it appears that the rules for issuing GO Bonds is regulated by type of entity. For example, sanitary and water districts have a discrete set of rules specific to their authorities in 2020 ORS, Vol. 12, Chapter 450: https://www.oregonlaws.org/ors/chapter/450.

Road Fund

A "county road fund" means a separate fund in the county treasury designated to receive deposit of revenues that are dedicated to roads or road improvements. The county road fund

must be used in establishing, laying out, opening, surveying, altering, improving, constructing, maintaining and repairing county roads and bridges on county roads (with exceptions).

See 2020 ORS, Vol. 10, Ch.238, Section 238.705: https://www.oregonlaws.org/ors/368.705

Special Tax District

Some districts, like Ports, may have authority to create special tax levies, such as a "bond sinking fund", that is "a special tax upon all taxable real and personal property situated within the port. Such annual levy shall not exceed one-tenth of one percent."

See 2020 ORS, Vol. 19, Ch. 777, Section 777.520. https://www.oregonlaws.org/ors/777.520

Foundation

Animal Grantmakers

https://animalgrantmakers.org/

Animal Grantmakers is philanthropy's leading affinity group for animal funders. Our members—foundations, public charities, corporate giving programs, individuals, and other philanthropists—work individually and collectively on domestic and global issues affecting all types of animals including natural disasters. Together, they envision a safer and kinder world for animals—and a better and more sustainable future for us all. Animal Grantmakers share with the public numerous resources for both grantmakers and grantseekers, in addition to a variety of animal protection resources.

Center for Disaster Philanthropy (CDP)

https://disasterphilanthropy.org/cdp-funds/our-grantmaking-process/

CDP grants support medium- and long-term recovery and resilience efforts in communities affected by natural and human-made hazards, including conflicts and humanitarian crises. With a focus on historically marginalized and at-risk populations, CDP prioritizes investments in local organizations to support a range of programs critical for individuals' and communities' recovery.

Craft Emergency Relief Fund (CERF+)

https://cerfplus.org/

CERF+'s Get Ready program provides individual craft artists grants up to $500 to conduct activities that will help safeguard their studios, protect their careers and prepare for emergencies. Artists are encouraged to use the Risk Assessment activity to generate ideas.

The CERF+ Emergency Relief grant focuses on artists working in craft or materials-based folk/traditional disciplines that are 18 years or older and have resided and worked in the U.S. or U.S. territories for the past 2 years. These artists must have experienced a recent, unforeseen, career threatening emergency.

Oregon Community Foundation

https://oregoncf.org

The Oregon Community Foundation (OCF) provides grants and scholarships across Oregon. As a statewide community foundation, they work alongside donors, stewarding their priorities into

strategic giving to support diverse communities across Oregon, creating lasting, transformative change. They have five offices and professional advisors to assist donors in setting up advised funds to serve seven areas of impact.

Meyer Memorial Trust

https://mmt.org/

Since 1982, Meyer Memorial Trust has awarded grants and program-related investments totaling more than $814 million to more than 3,380 organizations around the Pacific Northwest. Today, the Meyer Memorial Trust focuses on work in Oregon in four areas Oregonians have identified as crucial to making the state better for all its residents: housing, education, the environment and building stronger communities.

National Coalition for Arts Preparedness and Emergency Response (NCAPER)

https://www.ncaper.org/

NCAPER is a voluntary task force of national, regional, state, and local arts organizations, public agencies, and foundations, which help ensure that artists, arts/cultural organizations, cultural funders, and arts businesses have the capacity and ability to respond effectively to disasters and emergencies affecting the arts and culture sector. NCAPER also believes the Arts Sector is an essential collaborator in broader societal efforts for preparedness, emergency response, and recovery to ensure the resilience of the general community.

Northwest Health Foundation

https://www.northwesthealth.org/

Northwest Health Foundation (NWHF) seeks to advance, support, and promote health in Oregon and Southwest Washington. By providing grants to initiatives, forming partnerships with health and community leaders, and advocating for policy change, NWHF is furthering its vision of giving every person the opportunity to lead a healthy life, with a focus on advancing disability justice, civic health, and the justice reinvestment equity program. A recent grant is supporting the creation of emergency preparation education content by and for disabled communities, as well as the creation of wildfire preparedness kits to distribute to disabled community members.

The Collins Foundation

https://www.collinsfoundation.org/welcome-collins-foundation

The Collins Foundation invests in Oregon nonprofit organizations, both rural and urban, that are dedicated to improving quality of life and well-being for the people in their communities. As a funder and partner, The Collins Foundation is committed to the pursuit of equity, both in how they allocate resources across Oregon's diverse communities and how they shape our internal structures.

The Ford Family Foundation

https://www.tfff.org/grants/funding/

Grants aligned with our Community impact area support conditions that help children and families thrive in rural communities. This includes focusing on their local economies, social capital, community visioning and planning capacity, and public gathering spaces. Current grant

funding examples related to hazard mitigation include community building and engagement efforts, community centers and convening spaces, rural health centers, disaster resiliency planning, and fire halls.

State

AmeriCorps/Resource Assistance for Rural Environments (RARE), University of Oregon

https://rare.uoregon.edu/

The mission of the RARE AmeriCorps Program is to increase the capacity of rural communities to improve their economic, social, and environmental conditions, through the assistance of trained graduate-level members who live and work in communities for 11 months. Members assist communities and agencies in the development and implementation of plans for achieving a sustainable natural resource base and improving rural economic conditions while gaining community building and leadership skills.

Coastal Grants, DLCD

https://www.oregon.gov/lcd/OCMP/Pages/Grants.aspx

The Oregon Coastal Management Program (OCMP) at Oregon Department of Land Conservation and Development (DLCD) is pleased to announce a new National Oceanic and Atmospheric Administration (NOAA) funding opportunity designed to build a Climate Ready Nation under the 2021 Bipartisan Infrastructure Law (also known as the Infrastructure Investment and Jobs Act (IIJA)) and available only through coastal management programs. The objective of this initiative is to increase resilience through landscape-scale habitat restoration and conservation in coastal ecosystems nationwide and promote coastal resilience in underserved coastal communities as well as those most vulnerable to climate impacts.

Community Grants, DLCD

https://www.oregon.gov/lcd/cpu/pages/community-grants.aspx

The DLCD Community Services Division offers grants to empower local and tribal governments to improve planning. The grants can pay to update comprehensive plans, modernize land use ordinances, or augment other planning activities. The general fund grant program, administered by the community services division, is funded by the Oregon legislature. Changes to the grant program can arise based on changes in state priorities, the economy, and other factors. In general, the funding follows the state's two-year budget cycle and is part of DLCD's agency budget.

Community Risk Reduction Grants, OSFM

https://www.oregon.gov/osfm/wildfire/pages/investments-for-oregon.aspx

Oregon State Fire Marshall (OSFM) grant programs provide the following funding sources.

2023 Wildfire Season Staffing Grant

The 2023 Wildfire Season Staffing Grant funds local fire agencies to hire additional firefighters for the fire season. This additional capacity allows fire agencies to respond to other calls, improving response times, and ultimately saving lives.

Community Wildfire Risk Reduction Grant

This grant program is open to local governments, special districts, structural fire service agencies, and non-governmental organizations. This grant funds wildfire risk reduction projects, equipment, and staff.

Engine Program

This $25-million program is purchasing and strategically placing new firefighting equipment across Oregon. The OSFM is purchasing type 3, type 6, and tactical tenders to assist local host agencies in keeping fires small and away from communities.

Oregon Fire Service Capacity Program

The Fire Service Capacity Program is for small- to medium-sized agencies that need more permanent positions for firefighters and fire prevention staff. This grant is available to Oregon's local fire districts and departments for funds to support up to two firefighters and two fire prevention personnel.

Community Wildfire Protection Plan (CWPP) Investments

In February 2023, the OSFM made a strategic one-time $2.7 million investment at the local and county levels through CWPP. Projects will happen in 25 CWPP planning areas located in Baker, Benton, Clackamas, Coos, Crook, Curry, Deschutes, Douglas, Gilliam, Hood River, Jackson, Jefferson, Josephine, Lake, Lane, Lincoln, Linn, Malheur, Marion, Morrow, Multnomah, Polk, Wallowa, Wheeler, and Yamhill counties. Projects include promoting wildfire-specific community risk reduction efforts, community education, defensible space projects, home assessments, media campaigns, signage, fuel mitigation programs, and grant funds.

Emergency Shelter Grants and Supports, ODHS

https://www.oregon.gov/odhs/emergency-management/Pages/emergency-shelter.aspx

Oregon Department of Human Services (ODHS) provides assistance for local governments, Tribal Nations, public education providers, non-profits, and faith-based organizations to address shelter needs for:

- Cleaner air shelters during wildfire smoke and other poor air quality events
- Cooling and warming shelters

Landscape Resiliency Program, ODF

https://www.oregon.gov/odf/pages/landscape-resiliency-program.aspx

This grant program funded landscape-scale projects that reduce wildfire risk on public and private forestlands and rangelands, and in communities near homes and critical infrastructure through restoration of landscape resiliency and reduction of hazardous fuels. Oregon Department of Forestry (ODF), with input from the Landscape Resiliency Project work group and the public, has awarded $20 million for nine projects during the 2021–23 biennium.

Oregon State Weed Board Grant Program

https://www.oregon.gov/ODA/programs/Weeds/Pages/GrantProgram.aspx

The Oregon Department of Agriculture (ODA) and the Oregon Watershed Enhancement Board (OWEB) work together to administer the ODA Noxious Weed Grant Program Lottery funded grant program. The implementation of a comprehensive watershed approach to integrated control of noxious weeds is the most effective strategy to minimize impacts and protect natural resources in Oregon from invasive noxious weeds. It is a priority of the Oregon State Weed Board (OSWB) to fund projects that restore and enhance fish and wildlife habitat, watershed functions, and native salmonid populations.

Oregon Watershed Enhancement Board

http://www.oregon.gov/OWEB/Pages/index.aspx

While OWEB's primary responsibilities are implementing projects addressing coastal salmon restoration and improving water quality statewide, these projects can sometimes also benefit efforts to reduce flood and landslide hazards. In addition, OWEB conducts watershed workshops for landowners, watershed councils, educators, and others, and conducts a biennial conference highlighting watershed efforts statewide. Funding for OWEB programs comes from the general fund, state lottery, timber tax revenues, license plate revenues, angling license fees, and other sources. OWEB awards approximately $20 million in funding annually.

Resilience Hubs and Networks Grant, ODHS

https://www.oregon.gov/odhs/emergency-management/Pages/resilience-grants.aspx#faq

Oregon Department of Human Services (ODHS), Office of Resilience and Emergency Management, developed a new program to provide grants, support, and technical assistance to communities for planning and establishing resilience hubs and networks in Oregon, per HB 3409 (2023), effective date July 27, 2023. Applications are being accepted between February 21 and April 30, 2024, and ODHS staff intend to have all funding allocated by June 30, 2024.

Seismic Rehabilitation Grant Program, Business Oregon

https://www.oregon.gov/biz/programs/SRGP/Pages/default.aspx

The Seismic Rehabilitation Grant Program (SRGP) provides state funds to strengthen public schools and emergency services buildings so they will be less damaged during an earthquake. Reducing property damage, injuries, and casualties caused by earthquakes is the goal of the SRGP.

Small Forestland Grant Program, ODF

https://www.oregon.gov/odf/pages/small-forestland-grant-program.aspx

The Small Forestland Grant Program (SFGP) provides competitively awarded grants to support small forestland owners' properties by reducing wildfire risk and creating resiliency on the landscape. The project must reduce the risk of high severity wildfire by treating hazardous fuels, in addition to other eligibility requirements. This is a new annual grant program established under SB 762 (2021) with additional funding via SB 80 (2023).

Smoke Management - Community Response Plans for Smoke, DEQ

https://www.oregon.gov/deq/aq/Pages/Smoke-Management.aspx

Although prescribed fires are planned to occur during atmospheric conditions that limit smoke impacts, nearby communities may experience unintended smoke, therefore educating community members about smoke hazards and how to protect themselves is an important part of smoke management. ODF and DEQ recommend all SSRAs develop a Community Response Plan for smoke. The goal of a CRP is to promote communication between the entities that conduct prescribed fire, the local public health authority, vulnerable populations, and the public. A Community Response Plan toolkit and smoke resources are available for a community interested in developing its own CRP. The toolkit is available on the Oregon Prescribed Fire Council's webpage (https://www.oregonrxfire.org/) on smoke management.

Special Districts Association of Oregon (SDAO) Grant Resources website

https://www.sdao.com/grant-resources

SDAO provides a directory of funding resources. Some of the programs relate only to specific types of districts, while others are broad in their scope.

Special Public Works Fund (SPWF), Business Oregon

https://www.oregon.gov/biz/programs/SPWF/Pages/default.aspx

The Special Public Works Fund provides low-cost financing to eligible municipalities for planning, design, and construction of utilities and facilities essential to industrial growth, commercial enterprise, and job creation, including emergency projects as a result of a disaster.

State Interagency Hazard Mitigation Team (IHMT) website

http://www.oregon.gov/oem/Councils-and-Committees/Pages/IHMT.aspx

Find IHMT meeting dates and locations, agendas, minutes and meeting materials. The State IHMT is comprised of about 18 state agencies involved with natural hazards. The State IHMT meets quarterly to understand losses arising from natural hazards, coordinate recommended strategies to mitigate loss of life, property, and natural resources, and maintain the Oregon Natural Hazards Mitigation Plan.

State Preparedness and Incident Response Equipment (SPIRE)

https://spire-geo.hub.arcgis.com/

Oregon House Bill 2687 became effective in August 2017. It established a grant program to distribute emergency preparedness equipment to local governments and other recipients to be used to decrease risk of life and property resulting from an emergency. Items purchased must qualify as capital assets, meaning individual items must cost at least $5,000. A total of $5,000,000 is available to procure emergency preparedness equipment to help Oregon communities prepare, respond, and recover from emergencies. During the 2021 Legislative Session, HB 2426 added Urban Search and Rescue (USAR) equipment to the list and required that USAR equipment receive the highest priority. For more information on the SPIRE program, contact OEM.SPIRE@oem.oregon.gov.

Urban and Community Forestry Grants, ODF and USFS

https://www.fs.usda.gov/managing-land/urban-forests/ucf/2023-grant-funding

The Inflation Reduction Act (IRA) is a federal law that makes historic investments in clean energy and climate action. The IRA advances the Justice40 Initiative, which commits to providing 40 percent of climate, clean energy, and infrastructure investment benefits to overburdened and underserved communities. The IRA provides up to $1.5 billion to the United States Forest Service (USFS) for urban and community forestry investments to foster 1) increased and equitable access to urban tree canopy, 2) broadened community engagement in local urban forest planning, tree planting, and management activities, and 3) improved community and urban forest resilience. The Oregon Department of Forestry's (ODF's) Urban and Community Forestry (UCF) Program received $26.6 million in IRA grant funding from the USFS to stand up two grant programs.

Volunteer Fire Capacity Program, ODF

https://www.oregon.gov/ODF/AboutODF/Pages/GrantsIncentives.aspx

The Volunteer Fire Capacity (VFC) program is administered by ODF and funded through the US Department of Agriculture, Forest Service (USFS). The objective of the VFC program is to improve the capacity and capability of rural and volunteer fire protection districts. These districts protect rural communities and play a substantial cooperative role in the suppression of wildland fires within or near federally managed lands. The VFC award is administered as a reimbursement award.

Federal: Pre-/Post-Disaster

Center for Collaborative Heat Monitoring, National Integrated Heat Health Information System

https://www.heat.gov/pages/center-for-collaborative-heat-monitoring

The Center for Collaborative Heat Monitoring (CCHM) works directly with communities to co-create a heat monitoring plan tailored to community priorities. In November 2024, the CCHM opened applications for communities across the U.S. to monitor and evaluate factors influencing local heat risk. Funded through the Inflation Reduction Act, selected communities will receive $10,000 and technical support to collect heat distribution data through community-led campaigns.

Climate Resilience Regional Challenge, NOAA

https://coast.noaa.gov/funding/ira/resilience-challenge/

Approximately $575 million will be available for projects that build the resilience of coastal communities to extreme weather (e.g., hurricanes and storm surge) and other impacts of climate change (e.g., sea level rise, drought). Funding is made possible by the Inflation Reduction Act, a historic, federal government-wide investment that is advancing NOAA's efforts to build Climate-Ready Coasts.

Community Catalyst Fund, Community Navigator Program, USFS

https://co-co.org/community-navigator-program/

Coalitions and Collaboratives (COCO) is partnering with the US Forest Service and a team of national and regional nonprofits to deliver Community Navigator services. Community Navigators support community-based partners to access federal funding opportunities, create partnerships, and build capacity for wildfire risk mitigation and climate resilience. The goal is to connect communities with the right resources for building climate resilience when and where they need it most.

COCO's Community Catalyst Fund is intended to build community-serving organizational capacity towards climate resilience through access to funding and partnerships with the USFS. The community and/or project area must meet criteria for historically underserved communities. Applications that demonstrate meeting multiple criteria defined below will be prioritized. Communities defined as historically underserved as outlined by the Community Navigator Program include:

- Tribal governments and Indigenous communities
- Communities of color
- Communities at high risk of wildfire
- Communities at risk of extreme climate change impact
- Low-income rural communities
- Underserved communities of small acreage forest landowners (<2500)

Community Energy Programs (CEP), U.S. Department of Energy

https://www.energy.gov/scep/community-energy-programs

Community Energy Programs (CEP) provides federal support and resources to local and tribal governments, public schools, nonprofit organizations, workforce development groups, and other community-serving entities. The CEP includes the following: Energy Efficiency and Conservation Block Grant (EECBG) Program, Renew America's Nonprofits Program, Renew America's Schools Program, Communities Local Energy Action Program (Communities LEAP), and Workforce Development and Business Owner Training Program.

Dam Emergencies Collaborative Technical Assistance (CTA) Program, FEMA

https://www.fema.gov/emergency-managers/risk-management/dam-safety/technical-assistance

FEMA is offering a Collaborative Technical Assistance (CTA) series to help communities at risk of dam-related flooding to better understand their risk landscape and the potential consequences of dam-related emergencies. The CTA will include planning for emergencies related to operational discharges or dam-related infrastructure failure.

Disaster Loan Assistance, SBA

http://www.sba.gov/category/navigation-structure/loans-grants/small-business-loans/disaster-loans

There are four types of loans available from the U.S. Small Business Administration (SBA): home and personal property loans; business physical disaster loans; economic injury loans; and military reservist injury loans. When physical disaster loans are made to homeowners and businesses following disaster declarations by the SBA, up to 20% of the loan amount can go towards specific measures taken to protect against recurring damage in similar future disasters.

Disaster Recovery Unit (DRU), U.S. Department of Education

https://www.ed.gov/disasterrelief

The DRU coordinates disaster recovery work across the U.S. Department of Education. The DRU supports K-12 and higher education school communities to restore learning following a Federally declared natural disaster. Additionally, the DRU manages work with other U.S. government agencies to ensure effective and efficient use of the Department's natural disaster recovery resources.

Disaster Resources, U.S. Department of Housing and Urban Development (HUD)

https://www.hud.gov/disaster_resources

HUD provides a variety of disaster resources listed below. HUD also partners with Federal and state agencies to help implement disaster recovery assistance. Under the National Response Framework, the Federal Emergency Management Agency (FEMA) and the Small Business Administration (SBA) offer initial recovery assistance.

Community Development Block Grant Program (CDBG)

https://www.hud.gov/program_offices/comm_planning/cdbg-dr

The Community Development Block Grant Program (CDBG) is administered by HUD and promotes viable communities by providing decent housing; quality living environments; and economic opportunities, especially for low and moderate income persons. Eligible activities most relevant to natural hazards mitigation include acquisition of property for public purposes, construction/reconstruction of public infrastructure, and community planning activities. Under special circumstances, CDBG funds also can be used to meet urgent community development needs arising in the last 18 months which pose immediate threats to health and welfare. Grants are awarded based on specific projects as they are identified.

For Oregon, non-metropolitan cities and counties in rural Oregon can apply for and receive grants through Business Oregon. Oregon tribes, urban cities (Albany, Ashland, Beaverton, Bend, Corvallis, Eugene, Grants Pass, Gresham, Hillsboro, Medford, Portland, Redmond, Salem, and Springfield), and counties (Clackamas, Multnomah, Washington, Marion) receive funds directly from HUD. Visit: https://www.oregon.gov/biz/programs/CDBG/Pages/default.aspx

Additional assistance in Oregon is available through the Homeowner Assistance and Reconstruction Program (HARP) that offers financial assistance to help homeowners repair, rebuild, or replace homes lost or damaged in the 2020 Labor Day Disasters. These CDBG-Disaster Recovery (DR) funds are administered by Oregon Housing and Community Services (OHCS) through the effort called ReOregon. Visit: https://www.oregon.gov/ohcs/disaster-recovery/Pages/HARP%20draft%202.0.aspx

Community Development Block Grant Mitigation Program (CDBG-MIT)

https://www.hud.gov/program_offices/comm_planning/cdbg-dr/cdbg-mit

The CDBG-MIT Program funds pose a unique opportunity for eligible grantees to use this assistance in areas impacted by recent disasters to carry out strategic and high-impact activities to mitigate disaster risks and reduce future losses. The CDBG-MIT defines mitigation 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, and suffering and hardship by lessening the impact of future disasters. CDBG-MIT activities should align with other federal programs that address hazard mitigation to create a more cohesive effort at the federal, state, and local level.

Drinking Water Grants, EPA

https://www.epa.gov/ground-water-and-drinking-water/drinking-water-grants

The Environmental Protection Agency (EPA) provides a range of financial resources, including grants, made available to support public water systems with enhancing the quality of drinking water and improving public health. The Office of Water has a variety of funding programs available to public water systems. Included are the following:

- Water Infrastructure Improvements for the Nation Act (WIIN) Grants
- America's Water Infrastructure Act (AWIA) Grants
- Midsize and Large Drinking Water System Infrastructure Resilience and Sustainability Program
- Public Water System Supervision (PWSS) Grant Program
- Tribal Financial Resources
- Training and Technical Assistance for Small System Grants
- Bipartisan Infrastructure Law Drinking Water Financing

Food and Nutrition Service Disaster Resources, USDA

https://www.fns.usda.gov/disaster/disaster-assistance

The USDA Food and Nutrition Service (FNS) coordinates with state, local, and voluntary organizations to provide nutrition assistance to those most affected by a disaster or emergency. USDA Foods are currently stored in every state and U.S. territory and may be used by state agencies or local disaster relief organizations to provide food to shelters or people who are sheltering in place. If retail food stores are operating in the impacted area, state agencies may request to operate a Disaster Supplemental Nutrition Assistance Program (D-SNAP).

Flood Mitigation Assistance Program, FEMA

http://www.fema.gov/flood-mitigation-assistance-program

The overall goal of the Flood Mitigation Assistance (FMA) Program is to fund cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other National Flood Insurance Program (NFIP) insurable structures. This specifically includes:

- Reducing the number of repetitively or substantially damaged structures and the associated flood insurance claims;
- Encouraging long-term, comprehensive hazard mitigation planning;
- Responding to the needs of communities participating in the NFIP to expand their mitigation activities beyond floodplain development activities; and
- Complementing other federal and state mitigation programs with similar, long-term mitigation goals.

Emergency Management Performance Grants, FEMA

https://www.fema.gov/grants/preparedness/emergency-management-performance

Emergency Management Performance Grant (EMPG) program helps state and local governments to sustain and enhance their all-hazards emergency management programs.

Grid Resilience and Innovation Partnerships (GRIP) Program, U.S. Department of Energy

https://www.energy.gov/gdo/grid-resilience-and-innovation-partnerships-grip-program

The U.S. Department of Energy's Grid Deployment Office is administering a $10.5 billion Grid Resilience and Innovation Partnerships (GRIP) Program to enhance grid flexibility and improve the resilience of the power system against growing threats of extreme weather and climate change. The programs will help accelerate the deployment of transformative projects that will ensure the reliability of the power sector's infrastructure, so all American communities have access to affordable, reliable, clean electricity anytime, anywhere. The program includes three funding mechanisms: Grid Resilience Utility and Industry Grants, Smart Grid Grants, and Grid Innovation Program.

Hazard Mitigation Assistance (HMA), FEMA

https://www.fema.gov/grants/mitigation

Detailed program and application information for federal post-disaster and pre-disaster programs can be found in the Hazard Mitigation Assistance Program and Policy Guide, dated March 23, 2023. Note that guidance regularly changes. Verify that you have the most recent edition.

Non-disaster grants include the Building Resilient Infrastructure and Communities (BRIC) grant program, the Flood Mitigation Assistance grant program (FMA), and Pre-Disaster Mitigation Congressionally Directed Spending. See above for more information on the FMA grant program. These grants are administered by FEMA

Building Resilient Infrastructure and Communities (BRIC) Grant Program, FEMA

http://www.fema.gov/pre-disaster-mitigation-grant-program

The BRIC grant program provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations.

As of January 2024, FEMA will fund net-zero energy projects, including solar, heat pumps and efficient appliances, through the Public Assistance program (discussed below), but also offers incentives through its BRIC annual grant program to encourage more communities to use net-zero projects that increase community resilience.

BRIC and FMA grants are usually available on an annual basis. Applicants need to submit a pre-application to the Oregon Department of Emergency Management typically in the summer or fall. For Oregon Department of Emergency Management (OEM) grant guidance and procedures for applying for Federal Hazard Mitigation Assistance, including a link to sign up for funding notices, visit: https://www.oregon.gov/OEM/emresources/Grants/Pages/HMA.aspx

Contact for non-disaster grants: Stephen Richardson, State Hazard Mitigation Officer (SHMO), stephen.j.richardson@oem.oregon.gov, or Jon Wiebe, Non-Disaster Grants Specialist, Deputy State Hazard Mitigation Officer, jon.wiebe@oem.oregon.gov.

Hazard Mitigation Grant Program (HMGP), FEMA

https://www.fema.gov/grants/mitigation/hazard-mitigation

The Hazard Mitigation Grant Program (HMGP) provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The grant is administered by FEMA.

As of January 2024, FEMA will fund net-zero energy projects, including solar, heat pumps and efficient appliances, through the Public Assistance program (discussed below), but also funding net-zero energy projects for the HMGP to encourage more communities to use net-zero projects that increase community resilience.

For Oregon Department of Emergency Management (OEM) grant guidance and procedures for applying for Federal HMGP, including a link to sign up for funding notices, visit: https://www.oregon.gov/OEM/emresources/Grants/Pages/HMA.aspx

Contact for post-disaster grants: Stephen Richardson, Mitigation Section Manager, State Hazard Mitigation Officer (SHMO), stephen.richardson@oem.oregon.gov, or Kail Daniel, Deputy State Hazard Mitigation Officer (SHMO), Post-Disaster Grant Specialist, kail.daniel@oem.oregon.gov.

National Dam Safety Program (NDSP) State Assistance Grant Program, FEMA

https://www.fema.gov/emergency-managers/risk-management/dam-safety/grants

The primary purpose of the National Dam Safety Program (NDSP) State Assistance Grant Program is to provide financial assistance to the states for strengthening their dam safety programs.

- The states use NDSP funds for the following types of activities:
- Dam safety training for state personnel
- Increase in the number of dam inspections
- Increase in the submittal and testing of Emergency Action Plans
- More timely review and issuance of permits
- Improved coordination with state emergency preparedness officials
- Identification of dams to be repaired or removed
- Conduct dam safety awareness workshops and creation of dam safety videos and other outreach materials

National Estuary Program Watersheds Grant, Restore America's Estuaries

Restore America's Estuaries, in close coordination with and financial support from EPA, administers the National Estuaries Program (NEP) Watersheds Grants. This grant program funds projects within one or more of the NEP boundary areas and supports the following Congressionally-set priorities:

- Loss of key habitats resulting in significant impacts on fisheries and water quality such as seagrass, mangroves, tidal and freshwater wetlands, forested wetlands, kelp beds, shellfish beds, and coral reefs;
- Coastal resilience and extreme weather events including flooding and coastal erosion related to sea level rise, changing precipitation, warmer waters, or salt marsh, seagrass, or wetland degradation or loss and accelerated land loss;
- Impacts of nutrients and warmer water temperatures on aquatic life and ecosystems, including low dissolved oxygen conditions in estuarine waters;
- Stormwater runoff which not only can erode stream banks but can carry nutrients, sediment, and trash into rivers and streams that flow into estuaries;
- Recurring harmful algae blooms;
- Unusual or unexplained marine mammal mortalities; and
- Proliferation or invasion of species that limit recreational uses, threaten wastewater systems, or cause other ecosystem damage.

National Integrated Drought Information System (NIDIS), NOAA

https://www.drought.gov/drought-research/coping-with-drought-competition#open-competitions

NOAA's National Integrated Drought Information System announced up to $4 million in funding for 8 two-year projects as part of the Fiscal Year 2025 NIDIS Coping with Drought: Understanding and Assessing Drought in a Changing Climate competition. This competition seeks projects focused on improving drought indicator performance to account for non-stationarity with the goal of more accurate drought assessments that support communities in preparing for, mitigating, and responding to drought.

HOME Investments Partnerships Program (IPP), HUD

https://www.hud.gov/program_offices/comm_planning/home

The HOME IPP provides grants to states, local government and consortia for permanent and transitional housing (including support for property acquisition and rehabilitation) for low-income persons.

Neighborhood Stabilization Program (NSP), HUD

https://www.hud.gov/program_offices/comm_planning/nsp

The NSP was established for the purpose of providing emergency assistance to stabilize communities with high rates of abandoned and foreclosed homes, and to assist households whose annual incomes are up to 120 percent of the area median income.

Preparedness Grants, FEMA

https://www.fema.gov/grants/preparedness

FEMA's Preparedness grants support citizens and first responders to ensure we work together as a nation to build, sustain and improve our capability to prepare for, protect against, respond to, recover from and mitigate terrorism and other high-consequence disasters and emergencies.

Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Program, FHWA

https://www.fhwa.dot.gov/environment/protect/discretionary/

The vision of the PROTECT Discretionary Grant Program is to fund projects that address the climate crisis by improving the resilience of the surface transportation system, including highways, public transportation, ports, and intercity passenger rail. Projects selected under this program should be grounded in the best available scientific understanding of climate change risks, impacts, and vulnerabilities. They should support the continued operation or rapid recovery of crucial local, regional, or national surface transportation facilities. Furthermore, selected projects should utilize innovative and collaborative approaches to risk reduction, including the use of natural infrastructure, which is explicitly eligible under the program. Also called nature-based solutions, these strategies include conservation, restoration, or construction of riparian and streambed treatments, marshes, wetlands, native vegetation, stormwater bioswales, breakwaters, reefs, dunes, and shade trees. They reduce flood risks, erosion, wave damage, and heat impacts while also creating habitat, filtering pollutants, and providing recreational benefits. Projects in the PROTECT Discretionary Grant Program have the potential to demonstrate innovation and best practices that State and local governments in other parts of the country can consider replicating.

Public Assistance Grant Program, FEMA

http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit

The objective of the FEMA Public Assistance (PA) Grant Program is to provide assistance to State, Tribal and local governments, and certain types of Private Nonprofit organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President.

In January 2024, FEMA expanded funding to tackle the climate crisis, improve resilience, and cut energy costs through net-zero projects. It will fund net-zero energy projects, including solar, heat pumps and efficient appliances, through the PA program, which covers the rebuilding of schools, hospitals, fire stations and other community infrastructure investments post-disasters.

Readiness and Emergency Management for Schools (REMS)

http://rems.ed.gov/

REMS supports education agencies, with their community partners, manage safety, security, and emergency management programs. The REMS Technical Assistance (TA) Center helps to build the preparedness capacity (including prevention, protection, mitigation, response, and recovery efforts) of schools, school districts, institutions of higher education (IHEs), and their community partners at the local, state, and Federal levels. REMS TA Center also serves as the primary source of information dissemination for schools, school districts, and IHEs for emergencies.

Regional Catastrophic Preparedness Grant (RCPGP), FEMA

https://www.fema.gov/grants/preparedness/regional-catastrophic

The RCPGP plays an important role in the implementation of the National Preparedness System. RCPGP 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.

Housing was added as a strategic priority for this grant program in 2023 to accompany equity, climate resilience, and readiness. Priority will also be given to projects that address the needs of disadvantaged communities that might be at special risk as a result of current and/or future hazards, including those associated with climate change.

Rural Development Assistance – Utilities, USDA

https://www.rd.usda.gov/about-rd/agencies/rural-utilities-service

Direct and guaranteed rural economic loans and business enterprise grants to address utility issues and development needs.

Rural Development Assistance – Housing, USDA

https://www.rd.usda.gov/about-rd/agencies/rural-housing-service

The Rural Housing Service program provides grants, loans, and technical assistance in addressing rehabilitation, health and safety needs in primarily low-income rural areas. Declaration of major disaster is necessary.

Safeguarding Tomorrow Revolving Loan Fund Program, FEMA

https://www.fema.gov/grants/mitigation/storm-rlf

The Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) Act became law on January 1, 2021 and authorizes FEMA to provide capitalization grants to states, eligible federally recognized tribes, territories and the District of Columbia to establish revolving loan funds that provide hazard mitigation assistance for local governments to reduce risks from natural hazards and disasters. These low interest loans will allow jurisdictions to reduce vulnerability to natural disasters, foster greater community resilience and reduce disaster suffering.

Tribal Climate Resilience Annual Awards, BIA

https://www.bia.gov/service/tcr-annual-awards-program

The Bureau of Indian Affairs (BIA) Branch of Tribal Climate Resilience (TCR) provides financial support for federally recognized Tribal Nations and authorized Tribal organizations through a competitive funding opportunity to address current and future climate change impacts on Tribal Treaty and Trust resources, economies, regenerative agriculture and food sovereignty, conservation practices, infrastructure, and human health and safety. The 2024, funding categories include the following:

- Category 1 – Planning
- Category 2 – Implementation
- Category 3 – Relocation, Managed Retreat, Protect-in-Place Staff Salary

Water Research Grants, EPA

https://www.epa.gov/research-grants/water-research-grants

The EPA funds water research grants to develop and support the science and tools necessary to develop sustainable solutions to current water resource problems, ensuring water quality and availability in order to protect human and ecosystem health.

Water Resources Projects for Small or Disadvantaged Communities, USACE

https://www.usace.army.mil/Missions/Civil-Works/Project-Planning/Legislative-Links/wrda_2020/

The U.S. Army Corps of Engineers (USACE) is launching a pilot program to fully fund small water resources projects for economically disadvantaged communities. Project proposals are due by October 20, 2023. A more detailed description of the requirements for a project proposal can be found in the WRDA 2020 Section 165 policy guidance issued on June 12, 2023.

WaterSMART Grants, USBR

https://www.usbr.gov/watersmart/

Through WaterSMART Grants, the U.S. Bureau of Reclamation (USBR) provides financial assistance to water managers for projects that seek to conserve and use water more efficiently, implement renewable energy, investigate and develop water marketing strategies, mitigate conflict risk in areas at a high risk of future water conflict, and accomplish other benefits that contribute to sustainability in the western United States. Cost-shared projects that can be completed within two or three years are selected annually through a competitive process. Three categories of WaterSMART Grants are offered through separate funding opportunities: Water and Energy Efficiency Grants; Small-Scale Water Efficiency Projects; and Water Marketing Strategy Grants.

Western Regional Agricultural Stress Assistance Program (WRASAP), USDA

https://farmstress.us/

Funded by a USDA Farm and Ranch Stress Assistance Network grant, the WRASAP is composed of lead agencies representing 13 states and 4 territories. WRASAP recognizes that high levels of stress have been present in our agricultural communities. Causes include unstable finances, carrying the pressure of multigenerational farm lineage, injury, chronic/acute illness, adverse weather and climate change, and recent COVID-19 stressors. WRASAP wants to make sure that farmers, ranchers, farmworkers, and their families continue to have access to the resources needed, when they're needed. State-specific resources are available in Oregon, Washington, and Idaho.

Federal: Fire Resources

Assistance to Firefighters Grant Program Resources, FEMA

https://www.fema.gov/grants/preparedness/firefighters-old

FEMA's Assistance to Firefighters Grant Program provides a variety of resources listed below. The purpose of the grant is to provide equipment, protective gear, emergency vehicles, training, and other resources needed to protect the public and emergency personnel from fire and related hazards. The funds are available to fire departments, non-affiliated emergency medical services organizations, and state fire training academies. The funds enhance operations efficiencies, foster interoperability, and support community resilience.

Assistance to Firefighters Grants (AFG)

https://www.fema.gov/grants/preparedness/firefighters/assistance-grants

The primary goal of the Assistance to Firefighters Grant (AFG) is to meet the firefighting and emergency response needs of fire departments and non-affiliated emergency medical service organizations.

Staffing For Adequate Fire and Emergency Response (SAFER)

https://www.fema.gov/grants/preparedness/firefighters/safer

The SAFER program was created to provide funding directly to fire departments and volunteer firefighter interest organizations to help them increase or maintain the number of trained, "front line" firefighters available in their communities.

Fire Prevention and Safety (FP&S)

https://www.fema.gov/grants/preparedness/firefighters/safety-awards

The FP&S grant property is part of the AFG program noted above, and support projects that enhance the safety of the public and firefighters from fire and related hazards. The primary goal is to reduce injury and prevent death among high-risk populations.

Community Wildfire Defense Program, USDA/USFS

https://www.fs.usda.gov/managing-land/fire/grants

Oregon Department of Forestry manages the application process in Oregon.
https://www.oregon.gov/ODF/AboutODF/Pages/GrantsIncentives.aspx

The Community Wildfire Defense Program, or CWDG, is intended to help at-risk local communities and Tribes; plan for and reduce the risk of wildfire. This program, which was authorized by the Bipartisan Infrastructure Law, prioritizes at-risk communities in an area identified as having high or very high wildfire hazard potential, are low-income, or have been impacted by a severe disaster that affects the risk of wildfire. The program provides funding to communities for two primary purposes:

- Develop and revise Community Wildfire Protection Plans (CWPP).
- Implement projects described in a Community Wildfire Protection Plan that is less than ten years old.

The CWDG Program also helps communities in the wildland urban interface (WUI) implement the three goals of the National Cohesive Wildland Fire Management Strategy.

- Restore and Maintain Landscapes: Landscapes across all jurisdictions are resilient to fire-related disturbances, in accordance with management objectives.
- Create Fire Adapted Communities: Human populations and infrastructure can better withstand a wildfire without loss of life and property.
- Improve Wildfire Response: All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions.

The CWDG Dashboard provides a nationally consistent data dashboard to help communities complete grant applications and for reviewers to score applications.
https://wildfirerisk.org/cwdg-tool

National Fire Plan, USDA/USDOI

http://www.forestsandrangelands.gov/

The National Fire Plan (NFP) provides technical, financial, and resource guidance and support for wildland fire management across the United States. This plan addresses five key points: firefighting, rehabilitation, hazardous fuels reduction, community assistance, and accountability.

Wildfire Smoke Preparedness in Community Buildings Grant Program, EPA

https://www.epa.gov/indoor-air-quality-iaq/wildfire-smoke-preparedness-community-buildings-grant-program

Wildfire Smoke Preparedness in Community Buildings is a new federal grant program to support enhancing community wildfire smoke preparedness. It provides grants and cooperative agreements to States, federally recognized Tribes, public pre-schools, local educational agencies, and non-profit organizations for the assessment, prevention, control, and/or abatement of wildfire smoke hazards in community buildings and related activities.

Federal: Other, Hazard Mapping, Environmental Justice, and Technical Support

Clean Water State Revolving Fund (CWSRF), EPA

https://www.epa.gov/cwsrf

The EPA administers this fund. The purpose is to fund water quality projects, including all types of nonpoint source projects, watershed protection or restoration projects, estuary management projects, and more traditional municipal wastewater treatment projects. Grant awards are based on specific projects as they are identified.

Community Action for a Renewed Environment (CARE), EPA

https://www.epa.gov/international-cooperation/community-action-renewed-environment-care-roadmap-10-step-plan-improve

The administrator of this funding source is the EPA. The purpose is to fund the removal or reduction of toxic pollution. The grant award is based on specific projects as they are identified.

Community Change Grants Technical Assistance, EPA

https://www.epa.gov/inflation-reduction-act/community-change-grants-technical-assistance

Office of Environmental Justice and External Civil Rights at EPA is committed to providing robust technical assistance and resources to eligible entities. This assistance is in direct response to feedback from communities and environmental justice leaders who have long called for technical assistance and capacity building support for communities and their partners as they work to access critical federal resources. There are two programs dedicated to the Community Change Grants, which include Community Change Technical Assistance (CCTA) and Community Change Equitable Resilience Technical Assistance (CCER TA).

Confronting Hazards, Impacts and Risks for a Resilient Planet, NSF

https://new.nsf.gov/funding/opportunities/confronting-hazards-impacts-risks-resilient-planet?utm_medium=email&utm_source=govdelivery

In 2024, the National Science Foundation (NSF) announced a new funding opportunity through Confronting Hazards, Impacts and Risks for a Resilient Planet (CHIRRP). The goal of CHIRRP is to help safeguard communities and ecosystems for a resilient planet by supporting the co-design of projects that deliver evidence-based, actionable solution pathways reducing the risk from earth system hazards compounded by global environmental change. CHIRRP projects will demonstrate convergence of three essential elements: equitable community partnerships; an Earth-system science approach to advance knowledge of hazards, impacts and risks; and pathways to actionable solutions to increase environmental and societal resilience.

Cooperating Technical Partners, FEMA

https://www.fema.gov/flood-maps/guidance-partners/cooperating-technical-partners

The purpose of the CTP Program is to provide, through a Cooperative Agreement, funds to ensure that partners can perform program management and technical mapping-related activities.

Decision, Risk and Management Science Program (DRMS), National Science Foundation

https://new.nsf.gov/funding/opportunities/decision-risk-management-sciences-drms

Supports scientific research directed at increasing the understanding and effectiveness of decision making by individuals, groups, organizations, and society. Disciplinary and interdisciplinary research, doctoral dissertation research, and workshops are funded in the areas of judgment and decision making; decision analysis and decision aids; risk analysis, perception, and communication; societal and public policy decision making; management science and organizational design. The program also supports small grants for exploratory research of a time-critical or high-risk, potentially transformative nature.

Emergency Response for Drinking Water and Wastewater Utilities, EPA

https://www.epa.gov/waterutilityresponse

The Environmental Protection Agency (EPA) has a variety of tools and guidance to support drinking water and wastewater utility preparedness and response. Resources include:

Earthquake Resilience Guide for Water and Wastewater Utilities

There are three steps in this guide: Step 1 - Understand the Earthquake Threat. Step 2 - Identify Vulnerable Assets and Determine Consequences. Step 3 - Pursue Mitigation and Funding Options.

Emergency Watershed Protection Program, USDA-NRCS

https://www.nrcs.usda.gov/programs-initiatives/ewp-emergency-watershed-protection

Provides technical and financial assistance for relief from imminent hazards in small watersheds, and to reduce vulnerability of life and property in small watershed areas damaged by severe natural hazard events.

Environmental Justice Thriving Communities Grantmaking Program, EPA.

https://philanthropynw.org/epa-environmental-justice-thriving-communities-grantmaking-program

The Environmental Protection Agency's (EPA) Environmental Justice Thriving Communities Grantmaking Program aims to make it easier for community-based organizations to access federal environmental justice funding. Communities can apply to a regional Grantmaker, Philanthropy Northwest, for a subgrant to fund a range of different environmental project activities, including (but not limited to) small local clean ups, local emergency preparedness and disaster resiliency programs, environmental workforce development programs for local jobs reducing greenhouse gas emissions, fenceline air quality and asthma related projects, healthy homes programs, and projects addressing illegal dumping.

Environmental Quality Incentives Program, NRCS

https://www.nrcs.usda.gov/programs-initiatives/eqip-environmental-quality-incentives

The Environmental Quality Incentives Program (EQIP) is NRCS' flagship conservation program that helps farmers, ranchers and forest landowners integrate conservation into working lands. EQIP provides technical and financial assistance to agricultural producers and forest landowners to address natural resource concerns, such as:

- Improved water and air quality;
- Conserved ground and surface water;
- Increased soil health;
- Reduced soil erosion and sedimentation;
- Improved or created wildlife habitat; and
- Mitigation against drought and increasing weather volatility.

Equitable Resilience Builder (ERB), EPA

https://www.epa.gov/emergency-response-research/equitable-resilience-builder

Increasing resilience to disasters and climate change is an increasing challenge for communities. The ERB is an application that supports communities in resilience planning with a focus on equity. It engages users in a guided process to inclusively assess local hazards, equity, and the resilience of built, natural, and social environment systems. Results can be used to collaboratively prioritize actions to build community resilience in an equitable way.

Federal Funding for Water and Wastewater Utilities in National Disasters, EPA

https://www.epa.gov/fedfunds

The Federal Funding for Water and Wastewater Utilities in National Disasters (Fed FUNDS website gives utilities information about federal disaster funding programs. Although Fed FUNDS focuses on major disasters, you can use the information for any incident that disrupts water or wastewater services or damages critical infrastructure.

Federal Land Transfer / Federal Land to Parks Program, USDOI-NPS

http://www.nps.gov/ncrc/programs/flp/index.htm

The National Park Service Identifies, assesses, and transfers available federal real property for acquisition for state and local parks and recreation, such as open space.

Local Infrastructure Hub

https://localinfrastructure.org/

The Local Infrastructure Hub is a national program designed to connect cities and towns with the resources and expert advice they need to access federal infrastructure funding in order to drive local progress, improve communities, and deliver results for residents.

National Association of Flood and Stormwater Management Agencies (NAFSMA)

https://www.nafsma.org/awards-program

NAFSMA's awards programs, which are carried out under a mentoring agreement with the Federal Emergency Management Agency (FEMA), are open to all public agencies, as well as private firms working with a public agency

Excellence in Communications Awards

NAFSMA's Excellence in Communications awards program includes two categories — "Public Awareness of Flooding and/or Flood Prevention and/or Emergency Preparedness" and "Improving Water Quality." The Excellence in Communications awards program highlights award winning communication and outreach programs and provides examples of successful initiatives highlighting flood awareness, pollution prevention and environmental protection that are being carried out throughout the country

Innovative Water Projects

In 2022, NAFSMA launched a new awards program to recognize innovative multi-benefit water projects. The Innovative Water Project Awards Program recognizes community flood risk and/or stormwater and water quality management projects that accomplish multiple benefits. Examples of features and benefits that can be highlighted in project submissions include, but are not limited to, environmental justice, economic, water conservation, recreation, enhanced human health and well-being, endangered or protected species habitat creation, use of natural features and green infrastructure, and community enhancement.

National Coastal Zone Management Program, NOAA

https://coast.noaa.gov/czm/

Provides grants for planning and implementation of non-structural coastal flood and hurricane hazard mitigation projects and coastal wetlands restoration.

National Earthquake Hazard Reduction Program (NEHRP), National Science Foundation

http://www.nehrp.gov/

Through broad based participation, the NEHRP attempts to mitigate the effects of earthquakes. Member agencies in NEHRP include the US Geological Survey (USGS), National Science Foundation (NSF), Federal Emergency Management Agency (FEMA), and National Institute for Standards and Technology (NIST). The agencies focus on research and development in areas

such as the science of earthquakes, earthquake performance of buildings and other structures, societal impacts, and emergency response and recovery.

National Landslide Hazards Reduction Program (NLHRP), USGS

https://www.usgs.gov/programs/landslide-hazards/science/national-landslide-preparedness-act

On January 5, 2021 the National Landslide Preparedness Act (P.L. 116-323) was signed into law; it authorized a national landslide hazards reduction program and a 3D elevation program within the USGS. This broadened the already existing Landslide Hazards Program under the Natural Hazards Mission Area, and the 3D Elevation Program under the National Geospatial Program and required additional coordination with other federal agencies. The Act authorizes the National Landslide Hazards Reduction Program to do the following:

- Identify and understand landslide hazards and risks
- Reduce landslide losses
- Protect communities at risk
- Help improve communication, emergency preparedness by coordinating with communities and entities responsible for infrastructure at risk
- Establishes an Interagency Coordinating Committee on Landslide Hazards comprised of USGS and other Federal Agencies

National Tsunami Hazard Mitigation Program (NTHMP), NWS

https://nws.weather.gov/nthmp/

Through collaboration, coordination, and financial and technical support to partner states, the NTHMP works to reduce the impact of tsunamis on the nation. NTHMP activities affect, either directly or indirectly, everyone in the United States, including coastal residents and visitors, emergency managers, land-use planners, elected officials, educators, government and business organizations, the military, and the tourism and maritime industries. Financial assistance is provided to NTHMP partner states. These grants are the primary funding source for projects that further the efforts of the NTHMP and NOAA's TsunamiReady program. With this assistance, NTHMP partner states have been able to substantially improve the products and services they provide to coastal communities in a cost-effective way.

National Flood Insurance Program (NFIP), FEMA

https://www.fema.gov/flood-insurance

The NFIP makes available flood insurance to residents of communities that adopt and enforce minimum floodplain management requirements.

NFIP Flood Maps, FEMA

https://www.fema.gov/flood-maps

Flood insurance rate maps and floodplain management maps for all NFIP communities.

North American Wetland Conservation (NAWC), USDOI-FWS

https://www.fws.gov/program/north-american-wetlands-conservation

NAWC fund provides cost-share grants to stimulate public/private partnerships for the protection, restoration, and management of wetland habitats. The grant funds projects for wetlands conservation in the United States, Canada, and Mexico.

Readiness and Environmental Protection Integration (REPI), DOD

https://www.repi.mil/

While the U.S. Department of Defense (DOD) REPI's primary mission is to protect military readiness, REPI also benefits the environment by conserving land near military installations and ranges. REPI engages in partnerships that often work across boundaries and protect working lands (e.g., farms, forests, ranches), wildlife habitat, water resources, natural spaces for recreational opportunities, and threatened and endangered species. REPI is involved in nature-based solutions that help installations prevent, prepare for, and recover from anticipated or unanticipated changes in environmental conditions. REPI Installation Resilience Funding Opportunities include the following:

- REPI Challenge
- National Coastal Resilience Fund
- America the Beautiful Challenge
- Readiness and Recreation Initiative

Partners for Fish and Wildlife (PFW), USDOI-FWS

https://www.fws.gov/program/partners-fish-and-wildlife

The PFW program provides financial and technical assistance to private landowners interested in pursuing restoration projects affecting wetlands and riparian habitats.

Planning Assistance to States, USACE

https://www.poa.usace.army.mil/Missions/Civil-Works-and-Planning/Planning-Assistance-to-States/

The Planning Assistance to States (PAS) program is offered through the U.S. Army Corp of Engineers. The PAS has two types of planning assistance: Technical Assistance and Comprehensive Plans. This means that any State, or group of States, federally recognized Tribe, or U.S. Territories may partner with USACE under the PAS program to prepare a Comprehensive Plan or receive other forms of technical assistance. Regional coalitions of governmental entities may also partner with USACE to develop water resources Comprehensive Plans. Examples of past studies and activities completed under PAS include watershed planning, flood risk management, surface and groundwater quality, environmental conservation and restoration, water supply and demand, wetland delineations, stream assessments, and GIS mapping.

Secure Rural Schools and Community Self-Determination Act of 2000, USDA-FS

https://www.fs.usda.gov/working-with-us/secure-rural-schools

Reauthorized for FY2022, it was originally enacted in 2000 to provide five years of transitional assistance to rural counties affected by the decline in revenue from timber harvests on federal lands. Funds have been used for improvements to public schools, roads, and stewardship projects. Money is also available for maintaining infrastructure, improving the health of watersheds and ecosystems, protecting communities, and strengthening local economies.

USGS Natural Hazards

https://www.usgs.gov/mission-areas/natural-hazards

The USGS Natural Hazards Mission Area includes six science programs including Coastal & Marine Geology, Earthquake Hazards, Geomagnetism, Global Seismographic Network, Landslide Hazards, and Volcano Hazards. Through these programs, the USGS provides alerts and warnings of geologic hazards and interactive maps and data.

Wetlands Reserve Easements (WRE), USDA-NCRS

https://www.nrcs.usda.gov/programs-initiatives/wre-wetland-reserve-easements

The WRE program provides assistance to protect and restore wetlands through easements and restoration agreements.

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APPENDIX E: DOGAMI MULTI-HAZARD RISK REPORT FOR LINN COUNTY, OREGON

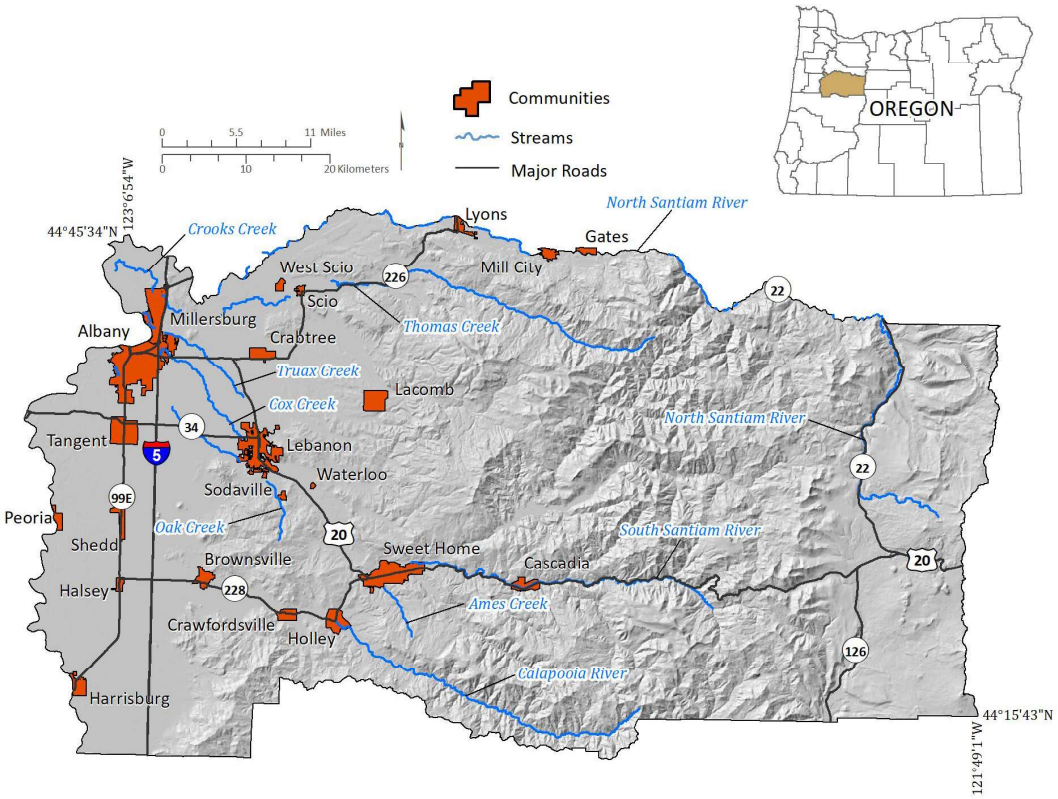
Note: the attached DOGAMI report has been compressed to allow for incorporation into this NHMP Volume. As such, some pages have been reduced in size and orientation has changed, and internal links may not be active. The report, map plates, and GIS data bundle are available for download from DOGAMI at: https://www.oregon.gov/dogami/pubs/Pages/ofr/p-O-24-15.aspx.

State of Oregon
Oregon Department of Geology and Mineral Industries
Ruarri J. Day-Stirrat, State Geologist

OPEN-FILE REPORT O-24-15

MULTI-HAZARD RISK REPORT FOR LINN COUNTY, OREGON

INCLUDING THE CITIES OF ALBANY, BROWNSVILLE, GATES, HALSEY, HARRISBURG, IDANHA, LEBANON, LYONS, MILL CITY, MILLERSBURG, SCIO, SODAVILLE, SWEET HOME, TANGENT, AND WATERLOO



by Matt C. Williams[1] and Jason D. McClaughry[1,2]

2024

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Cover image: Study area of the Linn County Risk Report. Map depicts Linn County, Oregon and communities included in this report.

WHAT'S IN THIS REPORT?

This report describes the methods and results of a natural hazard risk assessment for communities in Linn County. The results quantify the impacts of natural hazards to each community and enhance the decision-making process in planning for disaster.

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TABLE OF CONTENTS

Executive Summary **1**

1.0 Introduction **3**

1.1 Purpose 3
1.2 Study Area 4
1.3 Project Scope 5
1.4 Previous Studies 7

2.0 Methods **8**

2.1 Hazus Loss Estimation 8
2.2 Exposure 10
2.3 Building Inventory 11
2.4 Community Lifelines 14
2.5 Population 15

3.0 Assessment Overview and Results **16**

3.1 Earthquake 17
3.2 Flooding 27
3.3 Landslide Susceptibility 33
3.4 Channel Migration 37
3.5 Volcanic Hazard – Lahar 40
3.6 Wildfire 43

4.0 Conclusions **46**

5.0 Limitations **48**

6.0 Recommendations **49**

6.1 Awareness and Preparation 49
6.2 Planning 49
6.3 Emergency Response 50
6.4 Mitigation Funding Opportunities 50
6.5 Hazard-Specific Risk Reduction Actions 50

7.0 Acknowledgments **51**

8.0 References **52**

9.0 Appendices **55**

Appendix A. Community Risk Profiles 56
Appendix B. Detailed Risk Assessment Tables 83
Appendix C. Vulnerability Assessment of Lifelines 93
Appendix D. Hazus Methodology 98
Appendix E. Acronyms and Definitions 104
Appendix F. Map Plates 106

LIST OF FIGURES

Figure 1-1. Study area: Linn County with communities in this study identified....5
Figure 2-1. 100-year flood zone and building loss estimates example in rural Linn County, Oregon....9
Figure 2-2. Landslide susceptibility and building exposure example in Sweet Home, Oregon....10
Figure 2-3. Building occupancy types, City of Albany, Oregon....11
Figure 2-4. Community building value in Linn County by occupancy class....13
Figure 2-5. Population by Linn County community....16
Figure 3-1 CSZ plate interaction....17
Figure 3-2. Turner and Mill Creek Fault location....18
Figure 3-3. CSZ Mw 9.0 earthquake loss ratio by Linn County community....19
Figure 3-4. CSZ Mw 9.0 earthquake loss ratio in Linn County, with simulated seismic building code upgrades....22
Figure 3-5. Earthquake loss ratio from Turner and Mill Creek Fault Mw 6.6 by Linn County community....24
Figure 3-6. Turner and Mill Creek Fault Mw 6.6 earthquake loss ratio in Linn County, with simulated seismic building code upgrades....26
Figure 3-7. Flood depth grid example along the Willamette River in rural Linn County, Oregon....28
Figure 3-8. Ratio of flood loss estimates by Linn County community....30
Figure 3-9. Dams in Linn County....32
Figure 3-10. Landslide susceptibility exposure by Linn County community....35
Figure 3-11. Example diagram of the components of a CMZ map in Oregon....38
Figure 3-12. 30-year erosion hazard exposure by Linn County community....39
Figure 3-13. Lahar risk exposure by Linn County community. 42
Figure 3-14. Wildfire risk exposure by Linn County community 45

Figure C-1. Seismic design level by Linn County community....102

LIST OF TABLES

Table 1-1. Hazard data sources for Linn County 7
Table 2-1. Linn County building inventory 12
Table 2-2. Linn County critical facilities inventory 14

Table A-1. Unincorporated Linn County (rural) hazard profile 57
Table A-2. Unincorporated Linn County (rural) critical facilities 58
Table A-3. Unincorporated Community of Cascadia hazard profile 59
Table A-4. Unincorporated Community of Crabtree hazard profile 60
Table A-5. Unincorporated Community of Crabtree critical facilities 60
Table A-6. Unincorporated Community of Crawfordsville hazard profile 61
Table A-7. Unincorporated Community of Crawfordsville critical facilities 61
Table A-8. Unincorporated Community of Holley hazard profile 62
Table A-9. Unincorporated Community of Holley critical facilities 62
Table A-10. Unincorporated Community of Lacomb hazard profile 63
Table A-11. Unincorporated Community of Lacomb critical facilities 63
Table A-12. Unincorporated Community of Peoria hazard profile 64
Table A-13. Unincorporated Community of Peoria critical facilities 64
Table A-14. Unincorporated Community of Shedd hazard profile 65
Table A-15. Unincorporated Community of Shedd critical facilities 65
Table A-16. Unincorporated Community of West Scio hazard profile 66
Table A-17. City of Albany hazard profile 67
Table A-18. City of Albany critical facilities 68
Table A-19. City of Brownsville hazard profile 69
Table A-20. City of Brownsville critical facilities 69
Table A-21. City of Gates hazard profile 70
Table A-22. City of Gates critical facilities 70
Table A-23. City of Halsey hazard profile 71
Table A-24. City of Halsey critical facilities 71
Table A-25. City of Harrisburg hazard profile 72
Table A-26. City of Harrisburg critical facilities 72
Table A-27. City of Lebanon hazard profile 73
Table A-28. City of Lebanon critical facilities 74
Table A-29. City of Lyons hazard profile 75
Table A-30. City of Lyons critical facilities 75
Table A-31. City of Mill City hazard profile 76
Table A-32. City of Mill City critical facilities 76
Table A-33. City of Millersburg hazard profile 77
Table A-34. City of Millersburg critical facilities 77
Table A-35. City of Scio hazard profile 78
Table A-36. City of Scio critical facilities 78
Table A-37. City of Sodaville hazard profile 79
Table A-38. City of Sodaville critical facilities 79
Table A-39. City of Sweet Home hazard profile 80

Table A-40. City of Sweet Home critical facilities 80
Table A-41. City of Tangent hazard profile 81
Table A-42. City of Tangent critical facilities 81
Table A-43. City of Waterloo hazard profile 82
Table A-44. City of Waterloo critical facilities 82
Table B-1. Linn County building inventory 84
Table B-2. CSZ Mw-9.0 Earthquake loss estimates 85
Table B-3. Turner and Mill Creek Fault Mw-6.6 Earthquake loss estimates 86
Table B-4. Flood loss estimates 87
Table B-5. Flood exposure 88
Table B-6. Landslide exposure 89
Table B-7. Channel migration exposure 90
Table B-8. Wildfire exposure 91
Table B-9. Volcanic lahar hazard exposure 92
Table C-1. Inventory of Linn County high hazard potential dams. 93
Table C-2. Inventory of Linn County Bridges 93
Table C-3. Lifeline Risk by Polk County Community 95
Table C-1. Linn County seismic design level benchmark years 100
Table C-2. Seismic design level in Linn County 101

LIST OF MAP PLATES

Appendix F

Plate 1. Population Density Map of Linn County, Oregon....107
Plate 2. CSZ Mw-9.0 Earthquake Shaking Map of Linn County, Oregon....108
Plate 3. Turner and Mill Creek Fault Mw-6.6 Earthquake Shaking Map of Linn County, Oregon....109
Plate 4. Coseismic Landslide Susceptibility (Wet) Map of Linn County, Oregon....110
Plate 5. Liquefaction Susceptibility Map of Linn County, Oregon....111
Plate 6. Site Amplification Map of Linn County, Oregon....112
Plate 7. Flood Hazard Map of Linn County, Oregon....113
Plate 8. Landslide Susceptibility Map of Linn County, Oregon....114
Plate 9. Channel Migration Hazard Map of Linn County, Oregon....115
Plate 10. Wildfire Risk Map of Linn County, Oregon....116
Plate 11. Lahar Exposure Map of Linn County, Oregon....117

GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA

See the digital publication folder for files.
Geodatabase is Esri® version ArcGIS Pro 3.0. Metadata are embedded in the geodatabase and are also provided as separate .xml format files.

Linn_County_Risk_Report_Data.gdb
Feature dataset: Asset_Data
feature classes:
Building_footprints (polygons)
Communities (polygons)
UDF_points (points)

Linn_County_Depth_Grids.gdb:
FL_Depth_10
FL_Depth_50
FL_Depth_100
FL_Depth_500

Metadata in .xml file format:
Each dataset listed above has an associated, standalone .xml file containing metadata in the Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata format.

EXECUTIVE SUMMARY

This report was prepared for communities in Linn County, Oregon, with funding provided by the Oregon Department of Land Conservation and Development (DLCD). It describes the methods and results of a natural hazard risk assessment performed in 2024 by the Oregon Department of Geology and Mineral Industries (DOGAMI) within Linn County (herein referred to as the study area). The purpose of this project is to provide communities with detailed risk assessment information to enable them to understand and compare hazards on a community-by-community basis and act to reduce their risk. The risk assessment results quantify the consequences of natural hazards to each community by estimating the number of people and buildings at risk and support the decision-making process in planning for disaster.

We arrived at our results and conclusions by completing three main tasks: compiling an asset database, identifying and using the best available hazard data, and performing a natural hazard risk assessment.

- In the first task, we created a comprehensive asset database for Linn County by synthesizing assessor data, U.S. Census information, Federal Emergency Management Agency (FEMA) Hazus®-MH general building stock information, and building footprint data. This work resulted in a single dataset of building points and their associated characteristics (e.g., construction materials, number of floors, usage, etc.). Using these data, we were able to represent accurate spatial locations and vulnerabilities on a building-by-building basis. We also estimated the number of residents occupying residential structures so that we were able to approximate the number of people that might be at risk to a given hazard.
- The second task was to identify and use the most current and appropriate hazard datasets for the study area. The significant natural/geologic hazards affecting Linn County include: flooding, earthquakes, landslides, channel migration, wildfires, and volcanic lahars. Most of the hazard datasets used in this report were created by DOGAMI and produced using peer-reviewed methods and with lidar (high-resolution topographic data). Although not all the data sources used in the report provide complete, countywide information, each hazard dataset used was the best available at the time of the analysis. Data sources and coverage are discussed in detail for each hazard in **Section 3.0 Assessment Overview and Results**.
- In the third task, we analyzed risk using Esri® ArcGIS Desktop® software. We took two risk assessment approaches, depending on the nature of the hazard data: (1) estimated building losses (in dollars) were calculated for floods and earthquakes using the Hazus methodology, and (2) we calculated the number of buildings, their value, and associated populations exposed to earthquake, and flood scenarios, or susceptible to varying levels of hazard from landslides, channel migration, and wildfire. Details on recurrence intervals, susceptibility, hazard levels, and other particulars are discussed for each hazard in **Section 3.0 Assessment Overview and Results**.

The findings and conclusions of this report show the wide range of potential impacts hazards could have on the communities of Linn County. A Cascadia Subduction Zone (CSZ) earthquake magnitude 9.0 (Mw 9.0) is expected to cause extensive damage and losses throughout the county, with many of the critical facilities at High risk. A modeled Mw 6.6 earthquake focused on the Turner and Mill Creek Fault is expected to cause localized high damages for areas in the northwestern portion of Linn County. We demonstrate the potential for reduction in earthquake damages and losses through seismic retrofits using the building code simulations in the Hazus earthquake model. We also find that the highest potential for population displacement is associated with earthquake, wildfire, and landslide hazards. Flooding is

identified as a High-risk hazard event for some communities in the county (Brownsville, Crawfordsville, Scio, and Shedd) and we quantify the number of elevated structures that are less vulnerable to flood hazard. Our analysis shows that areas with moderate to steep slopes or at the base of steep hillsides are at the greatest risk from landslide hazards; such areas are present throughout the central and eastern portions of the county. More than 400 buildings along the North Santiam River and Santiam River are exposed to channel migration hazard. Wildfire exposure analysis shows a higher risk for buildings within the wildland-urban interface (WUI) in the eastern and central parts of the county. Volcanic lahar hazard that originates from Mount Jefferson could affect many buildings along the North Santiam River, especially in Gates.

Results were broken out for the following geographic areas:

- Unincorporated Linn County (rural)
- Community of Crabtree
- Community of Holley
- Community of Peoria
- Community of West Scio
- City of Brownsville
- City of Halsey
- City of Lebanon
- City of Mill City*
- City of Scio
- City of Sweet Home
- City of Waterloo
- Community of Cascadia
- Community of Crawfordsville
- Community of Lacomb
- Community of Shedd
- City of Albany*
- City of Gates**
- City of Harrisburg
- City of Lyons
- City of Millersburg
- City of Sodaville
- City of Tangent

*Only the portions of the cities of Albany and Mill City that are within Linn County are included in this report. The entirety of Mill City is included in O-22-05 (Marion County Multi-Hazard Risk Assessment) (Williams and Madin, 2022). The entirety of the City of Albany is included in O-23-06 (Benton County Multi-Hazard Risk Assessment) (Williams and Calhoun, 2023).

**The entirety of the City of Gates, which is in Linn and Marion Counties, is included in this report.

Selected countywide results Total buildings: 94,241 Total estimated building value: $27 billion	
Cascadia Subduction Zone Magnitude 9.0 Earthquake Scenario Red-tagged buildings[a]: 2,612 Yellow-tagged buildings[b]: 11,488 Loss estimate: $2.6 billion	**Turner and Mill Creek Fault Magnitude 6.6 Earthquake Scenario** Red-tagged buildings[a]: 2,749 Yellow-tagged buildings[b]: 8,942 Loss estimate: $2.4 billion
100-year Flood Scenario Number of buildings damaged: 1,973 Loss estimate: $99 million	**Landslide Exposure (High and Very High-Susceptibility)** Number of buildings exposed: 6,713 Exposed building value: $1.5 billion
Channel Migration Zone* (Erosion Hazard Area – 30-year) Number of buildings exposed: 420 Exposed building value: $110 million	**Wildfire Exposure (High and Moderate Risk)** Number of buildings exposed: 3,855 Exposed building value: $807 million
Lahar (1,000 to 15,000-year Scenario) Number of buildings exposed: 1,059 Exposed building value: $560 million	
[a]Red-tagged buildings are considered uninhabitable due to complete damage [b]Yellow-tagged buildings are considered limited habitability due to extensive damage *Results are limited to the study area of Appleby and others (2021), which covers the North Santiam River and Santiam River.	

The information presented in this report is designed to increase awareness of natural hazard risk, to support public outreach efforts, and to aid local decision-makers in developing comprehensive plans and natural hazard mitigation plans. This study can help emergency managers identify vulnerable critical facilities and develop contingencies in their response plans. The results of this study are designed to be used to help communities identify and prioritize mitigation actions that will improve community resilience.

1.0 INTRODUCTION

A *natural hazard* is an environmental phenomenon that can have negative consequences for humans. Where natural hazards have the potential to damage assets or harm people, the result is natural hazard *risk*. A natural hazard risk assessment identifies the applicable hazards and analyzes their consequences on the built environment and population, including the cost of recovery. Risk assessments provide key foundational information that can be used to develop mitigation plans, strategies, and actions, so that steps can be taken to prepare for a potential hazard event.

Key Terms:

- *Vulnerability:* Characteristics that make people or assets more susceptible to a natural hazard.
- *Risk:* Likelihood of occurrence multiplied by consequence; the degree of probability that a loss or injury may occur as a result of a natural hazard.

This is a multi-hazard risk assessment analyzing the consequences to buildings and people in Linn County. It provides a detailed and comprehensive analysis of natural hazard risk and provides a comparative perspective for communities within the study area not previously available. In this report, we describe our assessment results, which quantify the various levels of risk that each hazard presents to Linn County communities.

Linn County is located in the northwestern part of Oregon with the western half in the Willamette Valley and the eastern half in the Cascade Range. It is subject to a variety of natural hazards, including: earthquakes, riverine flooding, landslides, channel migration, wildfire, and volcanic lahars. This region of Oregon ranges from sparsely to heavily developed, including dense urban areas transitioning to suburban development in unincorporated parts of the study. There are also large uninhabited areas where the county jurisdiction extends into the Cascade Range.

1.1 Purpose

The purpose of this publication is to help communities in Linn County to better understand their natural hazards and risk, and increase resilience to earthquakes (including ground shaking, liquefaction and coseismic landslides), riverine flooding, landslides, channel migration, wildfire, and volcanic lahars. This is accomplished by using the best available, most accurate and detailed information about these hazards to assess the number of people and buildings at risk.

The main objectives of this study are to:

- compile a database of critical facilities, tax assessor data, buildings, and population distribution data,
- incorporate and use existing data from the most current geologic, hydrologic, and wildfire hazard studies,

- perform exposure and Hazus–based risk analyses, and
- share this publication widely so that all interested parties have access to its information and data.

The body of this report describes our methods and results. Two primary methods (Hazus loss estimation and exposure) were used to assess risk, depending on the type of hazard. These methods are described in the **Methods** section. Countywide results are reported for each hazard in **Community Risk Profiles**. Results for individual communities are detailed in **Appendix A: Community Risk Profiles**. **Appendix B** contains the detailed risk assessment tables used to generate the countywide results and community risk profiles. **Appendix C** contains results of vulnerability assessments for bridges, lifelines, and high hazard dams. **Appendix D** provides additional explanation of the Hazus methodology. **Appendix E** contains acronyms and definitions used throughout the report. **Appendix F** contains tabloid-size maps showing the spatial extent of the hazards, assets, and population across Linn County. These appendices can be helpful in clarifying the summarized results in each hazard section.

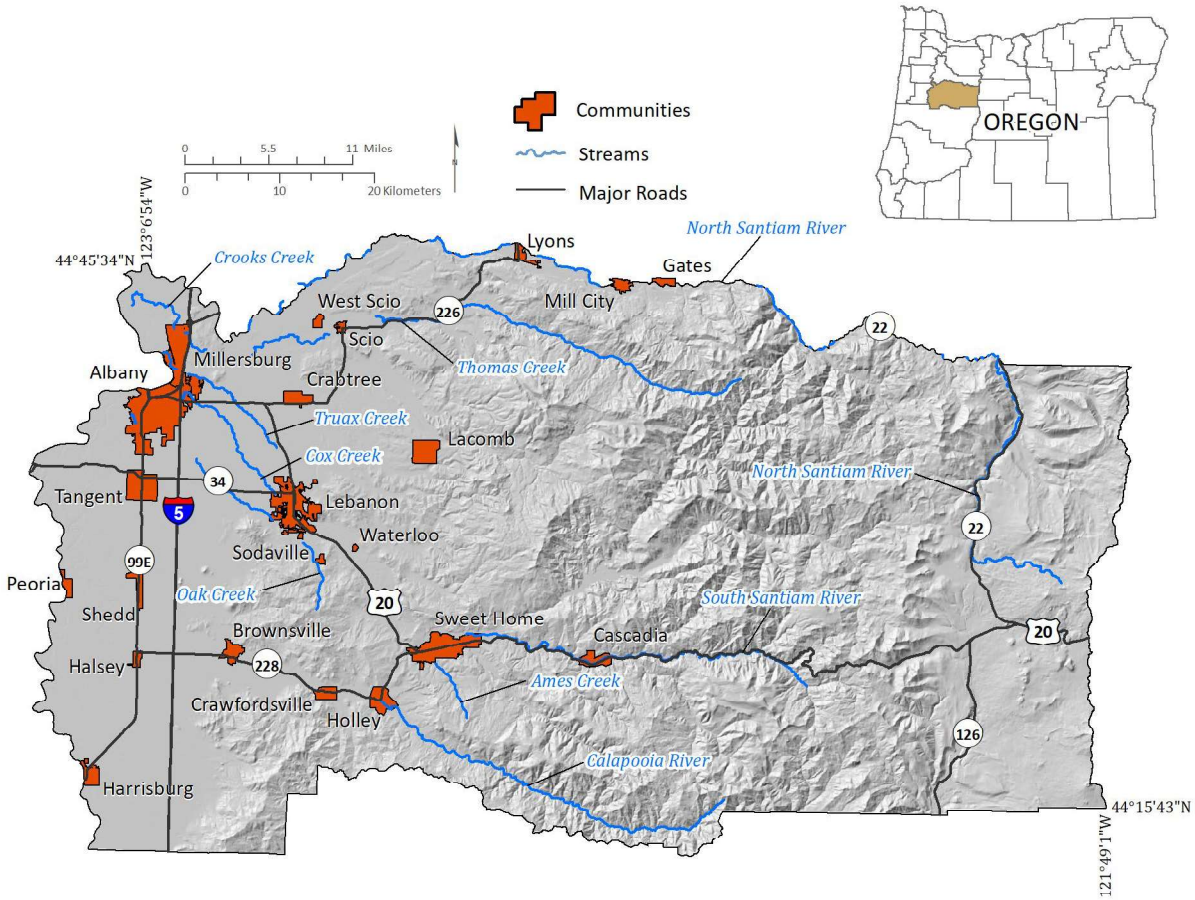
1.2 Study Area

The study area for this project includes the entirety of Linn County, Oregon (**Figure 1-1**). Linn County is located in the northwestern portion of the state; the county is bordered by Marion County to the north, Jefferson County and Deschutes County to the east, Lane County to the south, and Benton County and a small portion of Polk County to the west. The entire western boundary of Linn County with Benton County (and a small portion of Polk County) is defined by the north-flowing Willamette River. The total area of Linn County is 214 square miles (554 square kilometers).

The geography of eastern Linn County consists of the heavily forested Cascade Range. Mount Jefferson, a stratovolcano in the Cascade Range, is located at the northeastern corner of Linn County. Much of the land management for the county's eastern half is administered by the Willamette National Forest. The western half of the county transitions from the heavily forested mountains to gently rolling farmland and then onto the agricultural and intermixed urbanized broad flat bottom of the Willamette Valley.

The population of Linn County is approximately 132,000 people based on an estimated population for each community in 2023 from the Portland State University (PSU) Population Research Center https://www.pdx.edu/population-research/population-estimate-reports. Most people reside in the western half of the county. The City of Albany, which is largest in the county and the county seat, has a population of approximately 49,000. Other incorporated communities in the study area are Brownsville, Gates, Halsey, Harrisburg, Lebanon, Lyons, Mill City, Millersburg, Scio, Sodaville, Sweet Home, Tangent, and Waterloo (**Figure 1-1**). The unincorporated communities examined in this study are Cascadia, Crabtree, Crawfordsville, Holley, Lacomb, Peoria, Shedd, and West Scio. Portions of Albany in Benton County and Mill City in Marion County are not included in this study but are included in totality within their respective previously published countywide risk assessments (Williams and others, 2022; Williams and others, 2023). The portion of Gates that is within Marion County is included in this publication. The buildings in the Linn County portion of Idanha were included in this publication but were grouped into the unincorporated Linn County jurisdiction.

Figure 1-1. Study area: Linn County with communities in this study identified.



1.3 Project Scope

For this risk assessment, we limited the project scope to natural hazards affecting buildings and population because of data availability, the strengths and limitations of the risk assessment methodology, and funding availability. We did not directly analyze consequences to the local economy, stored hazardous materials, land values, socially vulnerable populations, infrastructure (e.g., transportation, power, water, gas, communication, and sewage), or the natural environment. Depending on the natural hazard, we used one of two methodologies: loss estimation or exposure. Loss estimation was modeled using Hazus®-MH (FEMA, 2022a, 2022b, 2022c), a tool developed by FEMA for calculating damage to buildings from flood and earthquake. Exposure is a simpler method, in which buildings are categorized based on their location relative to various hazard zones. Differences between loss estimation and exposure methods are described in the **Methods** section of the report. City and county population numbers from the PSU Population Research Center data were used to distribute people into residential structures based on square footage (https://www.pdx.edu/population-research/population-estimate-reports).

A critical component of this risk assessment is a countywide building inventory developed from building footprint data and the Linn County tax assessor database (acquired 2023). The other key component is datasets representing the best available science for a variety of natural hazards. The geologic hazard scenarios were selected by DOGAMI staff based on their expert knowledge of the area and the available hazard data; most datasets are DOGAMI publications. In addition to geologic hazards, we included wildfire hazard in this risk assessment. The following is a list of hazards considered in this study and what risk assessment methodologies were applied. See **Table 1-1** for data sources.

- Earthquake Risk Assessment
    - Hazus loss estimation from a CSZ earthquake magnitude Mw 9.0 scenario. This includes earthquake induced or "coseismic" liquefaction, soil amplification, and landslides.
    - Hazus loss estimation from a Turner and Mill Creek Fault Mw 6.6 scenario. This includes coseismic liquefaction, soil amplification, and landslides.
- Flood Risk Assessment
    - Hazus loss estimation to four recurrence intervals (10%, 2%, 1%, and 0.2% annual chance)
    - Exposure to 1% annual chance recurrence interval
- Landslide Risk Assessment
    - Exposure based on Landslide Susceptibility Zones and landslide deposit mapping
- Channel Migration Risk Assessment
    - Exposure based on the erosion hazard area—30-year (exposed, not exposed)
- Wildfire Risk Assessment
    - Exposure based on Overall Wildfire Risk (Low to High)
- Volcanic Lahar Risk Assessment
    - Exposure based on size and frequence (Small, Medium, Large Probability zones)

Table 1-1. Hazard data sources for Linn County.

Hazard	Scenario or Classes	Spatial Extent	Data Source
Earthquake	CSZ Mw 9.0	Regional (Pacific Northwest)	DOGAMI (Madin and others, 2021)
	Turner and Mill Creek Fault Mw 6.6	Regional (Pacific Northwest)	USGS (Personius, 2002) accessed via Hazus fault database
-Coseismic landslide	Susceptibility – wet (3-10 classes)	Statewide	DOGAMI (Madin and others, 2021)
-Coseismic liquefaction	Susceptibility (1-5 classes)	Statewide	DOGAMI (Madin and others, 2021)
-Coseismic soil amplification class	National Earthquake Hazards Reduction Program (A-F classes)	Statewide	DOGAMI (Madin and others, 2021)
Flood	Depth Grids: 10% (10-yr) 2% (50-yr) 1% (100-yr) 0.2% (500-yr)	Countywide	DOGAMI, derived from FEMA (2016) data included in GIS data for this report.
Landslide	Susceptibility (Low, Moderate, High, Very High)	Statewide	DOGAMI (Burns and others, 2016)
Channel Migration	Susceptibility (Not Exposed, Exposed)	North Santiam Rivers and tributaries	DOGAMI (Appleby and others, 2021)
Wildfire	Overall Wildfire Risk (Low, Moderate, High)	Regional (Pacific Northwest, US)	ODF (Gilbertson-Day and others, 2018)
Lahar	Size and frequency: Small (100 to 1,000-year) Medium (1,000 to 15,000-year) Large (>15,000-year)	Mount Jefferson and North Santiam River watershed	USGS (Walder and others, 1999)

1.4 Previous Studies

We are aware of one previous risk assessment that has been conducted for Linn County. Wang (1998) used Hazus to estimate the impact from a Mw 8.5 CSZ earthquake scenario on the state of Oregon. The results of the Wang (1998) study were arranged into individual counties. Linn County was estimated to experience a 5.12% loss ratio in the Mw 8.5 CSZ scenario due to its proximity to the earthquake source. Wang (1998) utilized a much lower level of detailed building information and site-specific earthquake hazard inputs. Because of these differences, comparative analysis was not beneficial to the scope of this project.

Burns and others (2008) developed earthquake and landslide hazard maps and used Hazus to estimate future earthquake damage for the mid-Southern Willamette Valley, including Linn County. Their Hazus analysis used a Mw 6.7 Mill Creek Fault earthquake and a Mw 8.5 CSZ earthquake. Both scenarios aggregated results at the census tract level using the default Hazus general building stock database. Estimated loss ratios for Linn County were 34% for the Mill Creek Fault and 29% for the CSZ scenario. This analysis also was not suitable for comparation in this report due to very different resolutions of input data (i.e., census tract level vs. building level).

2.0 METHODS

Where natural hazards have the potential to damage assets or harm people, the result is natural hazard *risk*. We used a quantitative approach through two modes of analysis, Hazus loss estimation and exposure, to assess the level of risk to assets and people using building value ($) and displaced population, respectively.

2.1 Hazus Loss Estimation

Key Terms:

- *Loss estimation:* Damage in terms of value that occurs to a building in an earthquake or flood scenario, as modeled with Hazus methodology. This is measured as the cost to repair or replace the damaged building in US dollars.
- *Loss ratio:* Percentage of estimated loss relative to the total value.

We used Hazus version 6.0 (FEMA, 2022a), which was the latest version available when we began this risk assessment. According to FEMA (FEMA, 2022a, p. 1-1), "The Hazus Loss Estimation Methodology provides state, local, tribal, and territorial officials with a decision support software for estimating potential losses from four natural hazards: floods, hurricanes, earthquakes, and tsunamis. This loss estimation capability enables users to anticipate the consequences of natural hazard events and develop plans and strategies for reducing risk […]. The use of this standardized methodology provides nationally comparable estimates that allow the federal government to plan natural hazard responses and guide the allocation of resources to stimulate risk mitigation efforts."

Hazus can be used in different modes depending on the level of detail required. Given the high spatial precision of the building inventory data and quality of the natural hazard data available for this study, we chose the user-defined facility (UDF) mode. This mode makes loss estimations for individual buildings relative to their "cost," which we then aggregate to the community level to report loss ratios. Costs used in this mode are associated with rebuilding using new materials, also known as replacement cost. Replacement cost is determined using a method called RSMeans valuation (Charest, 2017) and is calculated by multiplying the building area (in square feet) by a standard cost per square foot. These standard rates per square foot are in tables within the default Hazus database.

Damage functions are at the core of Hazus. The damage functions stored within the Hazus data model were developed and calibrated from the observed results of past disasters. We estimated damage and loss by intersecting building locations with natural hazard layers and applying damage functions based on the hazard severity (e.g., depth of flooding) and building characteristics (e.g., first floor height). **Figure 2-1** illustrates the range of building loss estimates from a Hazus flood analysis. In this example, most buildings within the 100-year flood zone are estimated to experience losses ranging from 0 to 15%. Buildings with a first-floor height above the level of flooding and those outside the flood zone are expected to experience no losses.

Figure 2-1. 100-year flood zone and building loss estimates example in rural Linn County, Oregon.

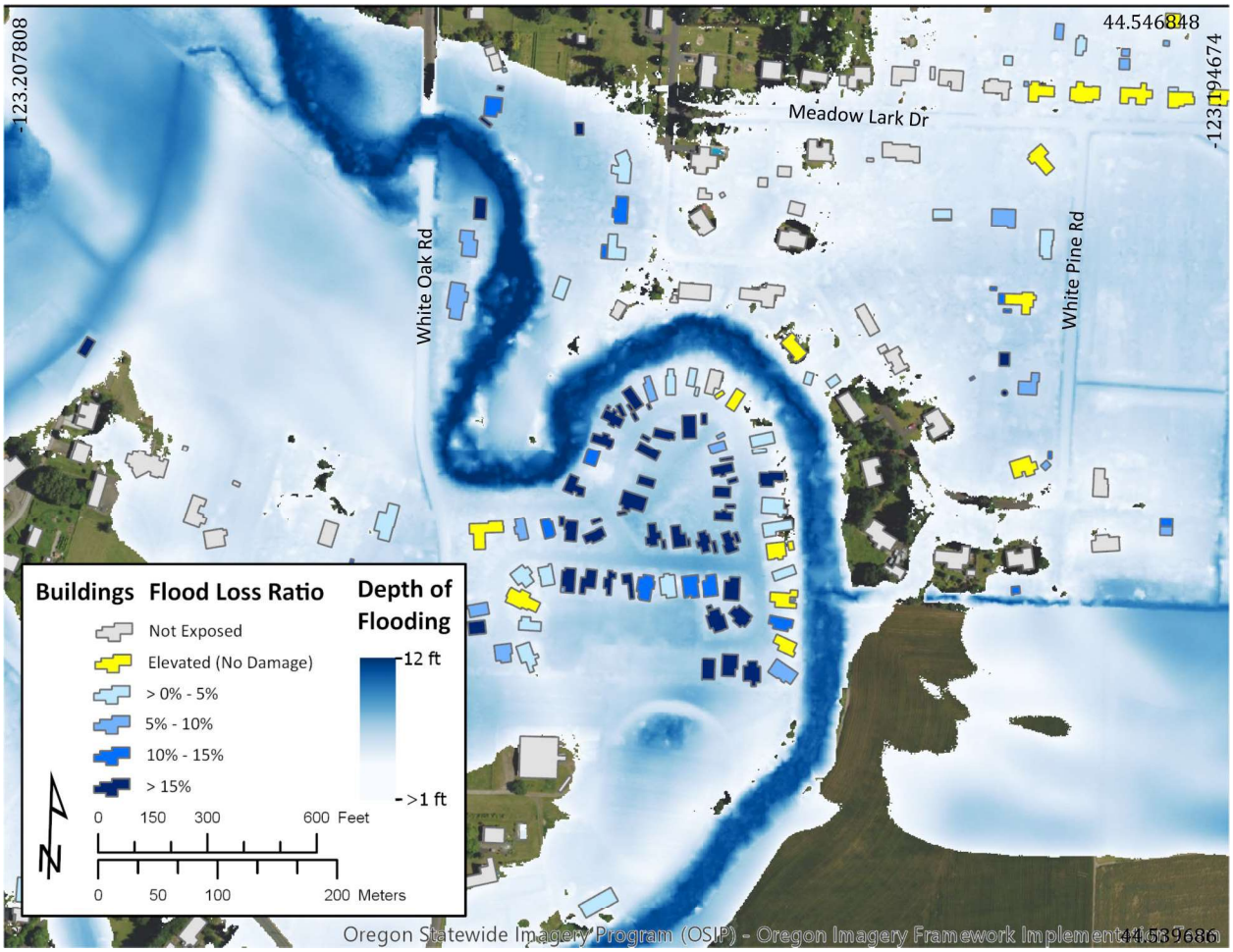


Image source: Oregon Statewide Imagery Program, 2018

Depth grid: Derived from the effective FEMA Flood Insurance Rate Map data for Linn County, 2016

2.2 Exposure

Key Terms:

- *Exposure:* Determination of whether a building is within or outside of a hazard zone. No loss estimation is modeled.
- *Building value:* Total monetary value of a building. This term is used in the context of exposure.

Since loss estimation using Hazus is not available for all types of natural hazards, we used exposure analysis to assess landslide, channel migration, wildfire, and volcanic lahar risk. Exposure methodology identifies the buildings and population that are within a particular natural hazard zone. This is an alternative to the more detailed loss estimation method for those natural hazards that do not have available damage models like in Hazus. It provides a way to easily quantify what is and is not threatened. Exposure results are communicated in terms of total building value exposed, rather than a loss estimate. For example, **Figure 2-2** shows buildings that are exposed to different levels of landslide susceptibility with building footprints colored based on what susceptibility zone the center of the building is within.

Exposure is used for landslide, channel migration, wildfire, and volcanic lahar hazards. We perform both analyses for the 100-year flood hazard scenario to allow for a broader perspective of the flood risk.

Figure 2-2. Landslide susceptibility and building exposure example in Sweet Home, Oregon.

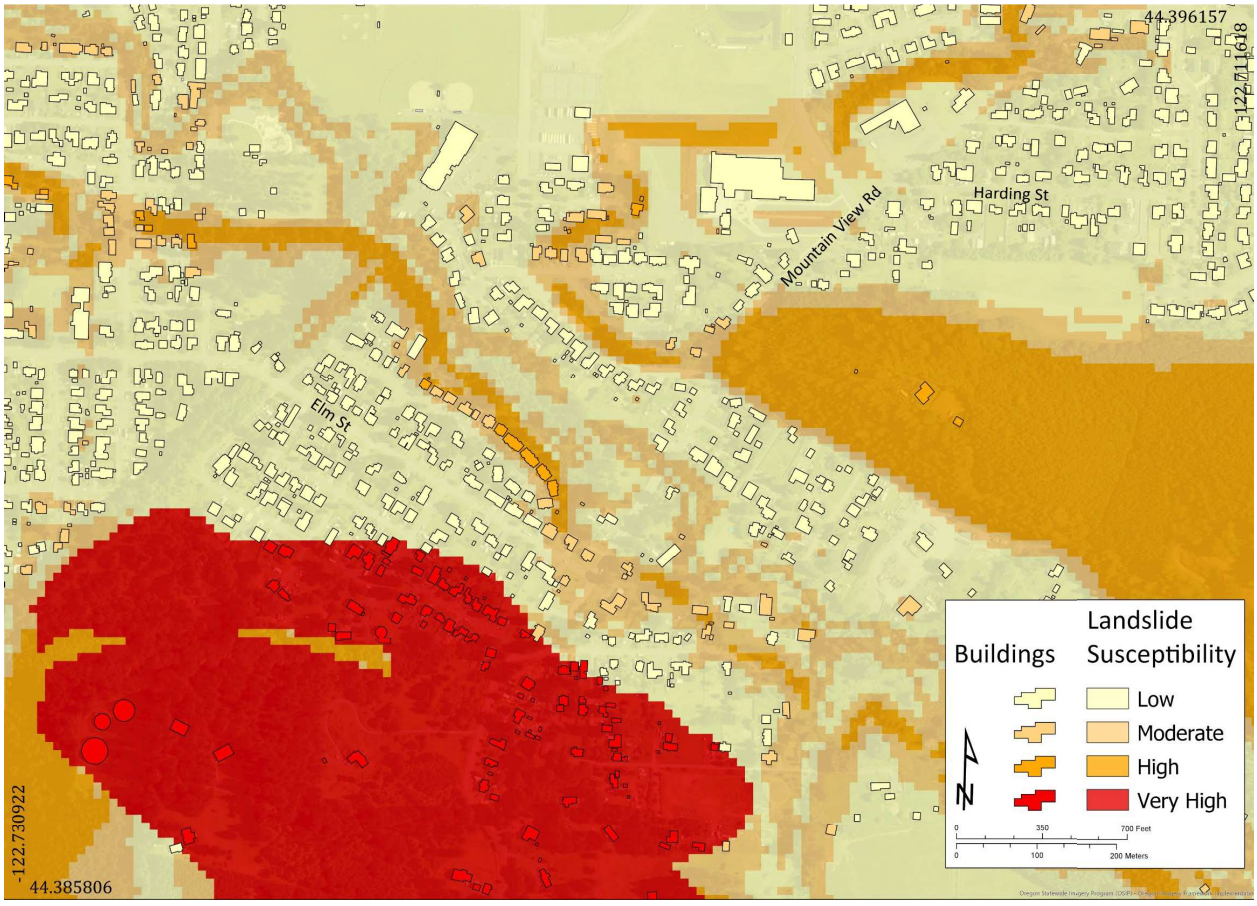


Image source: Oregon Statewide Imagery Program, 2018

Landslide data source: Landslide susceptibility overview map of Oregon, (Burns and others, 2016)

2.3 Building Inventory

A key piece of the risk assessment is the countywide building inventory. This inventory consists of all buildings larger than 9.3 square meters (100 square feet), as determined from existing building footprints (Williams, 2021). **Figure 2-3** shows an example of building inventory occupancy types used in this study. See also **Appendix B: Table B-1.**

To use the building inventory within Hazus, we converted the building footprint polygons to points and migrated them into a UDF database with standardized field names and attribute domains. The UDF database formatting allows for the correct damage function to be applied to each building. Hazus version 5.1 technical manuals (FEMA, 2022a, 2022b, 2022c) provide references for acceptable field names, field types, and attributes. The fields and attributes used in the UDF database (including building seismic codes) are discussed in more detail in **Appendix C.2.2**.

Figure 2-3. Building occupancy types, City of Albany, Oregon.

The number of buildings and total building value per community varies significantly in Linn County, with 136 buildings and $26 million for Peoria to 20,286 buildings and $7 billion for Albany (**Table 2-1).** A table detailing the occupancy class distribution by community is included in **Appendix B: Detailed Risk Assessment Tables**.

Table 2-1. Linn County building inventory.

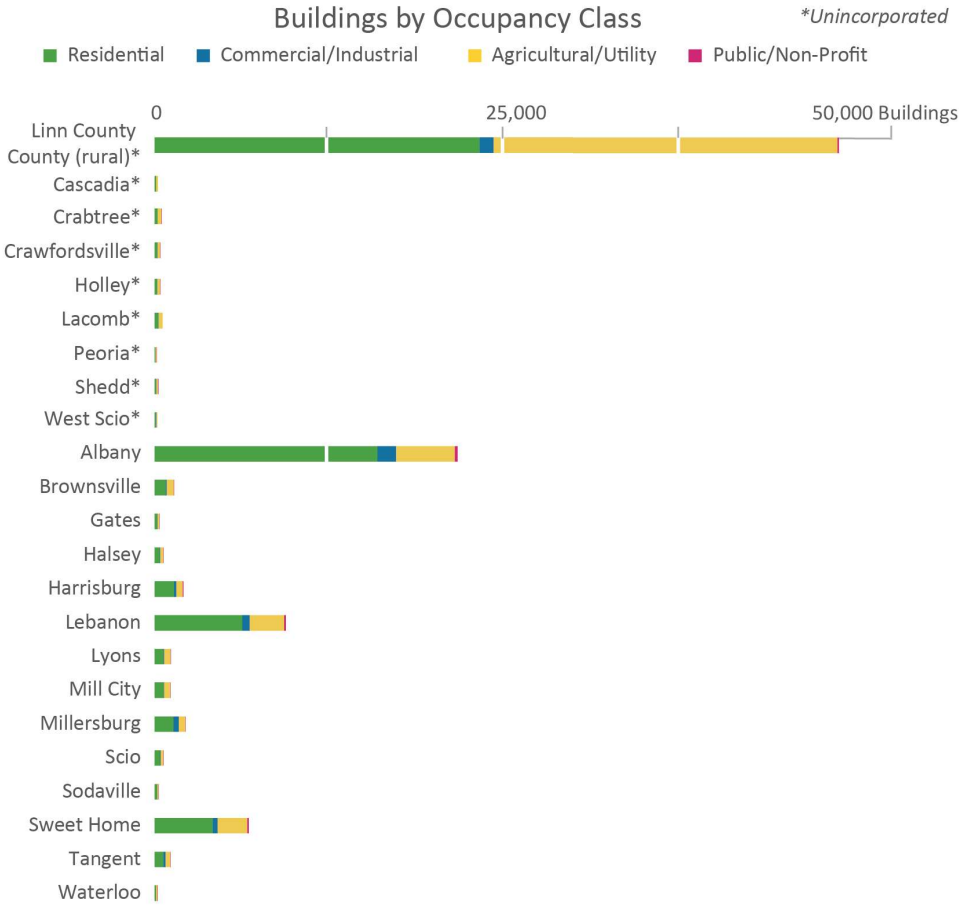
Community	Total Number of Buildings	Percentage of Total Buildings	Estimated Total Building Value ($)	Percentage of Total Building Value
Unincorp. Linn Co (rural)	45,792	49%	12,020,435,000	45%
Cascadia	231	0.2%	27,896,000	0.1%
Crabtree	459	0.5%	97,309,000	0.4%
Crawfordsville	374	0.4%	80,383,000	0.3%
Holley	380	0.4%	79,188,000	0.3%
Lacomb	535	0.6%	126,968,000	0.5%
Peoria	136	0.1%	25,591,000	0.1%
Shedd	248	0.3%	107,103,000	0.4%
West Scio	198	0.2%	52,104,000	0.2%
Total Unincorporated County	48,351	51%	12,616,823,000	47%
Albany	20,286	22%	7,004,487,000	26%
Brownsville	1,326	1.4%	284,607,000	1.1%
Gates	326	0.3%	70,923,000	0.3%
Halsey	602	0.6%	182,922,000	0.7%
Harrisburg	1,924	2.0%	544,762,000	2.0%
Lebanon	8,789	9.3%	2,688,032,000	10.%
Lyons	1,074	1.1%	223,889,000	0.8%
Mill City	1,060	1.1%	237,466,000	0.9%
Millersburg	2,049	2.2%	878,299,000	3.3%
Scio	601	0.6%	156,690,000	0.6%
Sodaville	271	0.3%	48,953,000	0.2%
Sweet Home	6,313	6.7%	1,466,569,000	5.5%
Tangent	1,064	1.1%	407,086,000	1.5%
Waterloo	203	0.2%	32,851,000	0.1%
Total Study Area	94,241	100%	26,844,514,000	100%

The building inventory was developed from the Statewide Building Footprints for Oregon, release 1 (SBFO-1) (Williams, 2021). The SBFO-1 data of Linn County was modified from a building footprints dataset maintained by Linn County, obtained June 2020. The building footprints provide a location and 2D outline of each structure. There are a total of 93,964 buildings within the study area. We define buildings to be permanent structures with walls and a roof that can be occupied by people (Williams, 2021). Other structures, such as dams, water tanks/towers, sewage and water treatment tanks, tents, small garden sheds, hoop-houses or other plastic-covered greenhouses, and grain silos, were not considered buildings and were not included in this analysis.

The Linn County Assessment Office supplied assessor data and we formatted it for use in this study. The assessor data contains an array of information about each improvement (e.g., building). Tax lot data, which contains property boundaries and other information regarding the property, was obtained from the county assessor and was used to link the buildings with assessor data. The linkage between the two datasets resulted in a database of UDF points that contain attributes for each building. These points are used in the risk assessment for both loss estimation and analyses. Albany and Lebanon are the

communities with the highest total number of buildings and residential use is the most common countywide (**Figure 2-4**).

Figure 2-4. Community building value in Linn County by occupancy class.



Some buildings are defined as critical facilities because they function in support of public safety, disaster recovery, relief efforts, and other emergency operations before, during, and after a natural disaster. Typical critical facilities include hospitals, schools, fire stations, police stations, emergency operations, and military facilities. Other critical infrastructure considered in this study include public works and water treatment facilities. We embedded identifying characteristics into the critical facilities in the UDF database so they could be highlighted in the results. Critical facilities data came from the DOGAMI Statewide Seismic Needs Assessment (SSNA; Lewis, 2007). We updated the SSNA data through coordination with Linn County officials. Communities that have critical facilities that can function during and immediately after a natural disaster are more resilient than those with critical facilities that are inoperable after a disaster. Critical facilities are present throughout the county with most in Albany and Lebanon (**Table 2-2**). Critical facilities are listed for each community in **Appendix A**.

Table 2-2. Linn County critical facilities inventory.

Community	Hospital & Clinic		School		Police/Fire		Emergency Services		Military		Other*		Total	
	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)
						(all dollar amounts in thousands)								
Unincorp. Linn Co (rural)	1	681	10	42,723	7	5,329	0	0	0	0	8	1,403	26	50,136
Cascadia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crabtree	0	0	0	0	1	1,116	0	0	0	0	0	0	1	1,116
Crawfordsville	0	0	1	5,910	1	273	0	0	0	0	0	0	2	6,183
Holley	0	0	1	5,142	0	0	0	0	0	0	0	0	1	5,142
Lacomb	0	0	1	5,679	1	318	0	0	0	0	0	0	2	5,998
Peoria	0	0	0	0	1	380	0	0	0	0	0	0	1	380
Shedd	0	0	0	0	1	1,216	0	0	0	0	0	0	1	1,216
West Scio	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Unincorporated County	1	681	13	59,454	12	8,633	0	0	0	0	8	1,403	34	70,171
Albany	10	39,833	21	185,607	4	9,129	0	0	0	0	6	68,552	41	303,121
Brownsville	0	0	0	0	1	1,811	0	0	0	0	1	565	2	2,376
Gates	0	0	0	0	1	1,227	0	0	0	0	1	574	2	1,800
Halsey	0	0	1	14,568	1	3,261	0	0	0	0	3	1,592	5	19,421
Harrisburg	0	0	2	31,101	2	1,979	0	0	0	0	0	0	4	33,080
Lebanon	10	76,229	7	111,759	4	11,507	0	0	2	4,677	8	16,722	31	220,893
Lyons	0	0	1	4,478	1	1,592	0	0	0	0	3	537	5	6,607
Mill City	0	0	2	24,237	2	1,971	0	0	0	0	0	0	4	26,208
Millersburg	0	0	0	0	2	3,186	0	0	0	0	1	1,255	3	4,441
Scio	0	0	3	16,491	1	2,423	0	0	0	0	1	1,094	5	20,008
Sodaville	0	0	1	2,343	0	0	0	0	0	0	2	223	3	2,566
Sweet Home	0	0	5	84,987	4	5,427	0	0	0	0	1	2,728	10	93,142
Tangent	0	0	2	7,781	1	2,373	0	0	0	0	1	432	4	10,586
Waterloo	0	0	0	0	0	0	0	0	0	0	1	75	1	75
Total Study Area	21	116,743	58	542,805	36	54,518	0	0	2	4,677	37	95,753	154	814,496

Note: Facilities with multiple buildings were consolidated into one building.

* Category includes buildings that are not traditional (emergency response) critical facilities but considered critical during an emergency based on input from local stakeholders (e.g., water treatment facilities or airports).

2.4 Community Lifelines

Lifelines are important structures that, when functioning during or immediately after an emergency, can enable a community to meet the health, safety, and economic needs of its residents. Lifelines provide fundamental services that can minimize direct and indirect consequences from a natural disaster and expediate the recovery process. These services meet a community's day-to-day needs and, when not functioning, are highly disruptive and can exacerbate the negative consequences of a natural disaster. In this report, lifelines include bridges, communication infrastructure, fuel supply, food centers, financial institutions, and high-occupancy buildings. We obtained data regarding lifelines from information provided by Linn County officials and the Oregon Department of Transportation (ODOT) (ODOT, 2023). Other lifeline categories that are not examined in this report include power distribution, highways, hazardous storage, and some aspects of water infrastructure.

Bridges are considered a highly important infrastructure lifeline and are vital to public safety. During a natural disaster, bridges are crucial for emergency response, evacuation, and recovery. Bridges that are

functioning after a disaster increase a community's ability to recover by facilitating the transportation of goods and services for relief. We identified bridges that could be at risk from hazards addressed in this report. A list of all bridges that are greater than 500 ft in length within Linn County are included in **Appendix C: Vulnerability Assessment of Lifelines**.

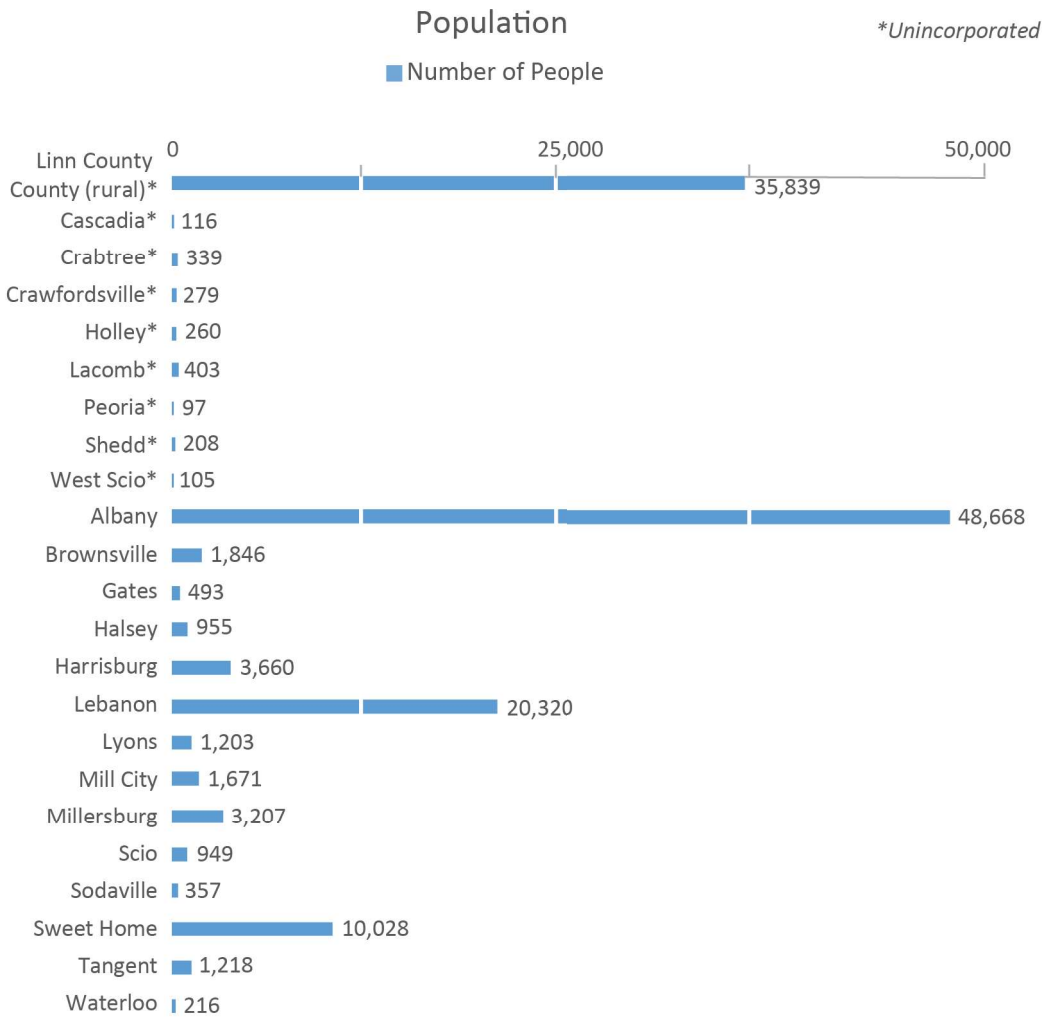
Some of the communities of Linn County provided a list of fuel supply, food distribution, and high-occupancy buildings. DOGAMI derived a list of financial institutions based on the county assessor dataset. We conducted a risk assessment for each structure identified in the list. These facilities were anonymized at the community level to address privacy concerns; however, individual structures can be identified in the GIS database included with this report. The results of this analysis are included in **Appendix C: Vulnerability Assessment of Lifelines.**

2.5 Population

One purpose of the UDF database design was so that we could estimate the number of people at risk from natural hazards. Within the UDF database, the PSU Population Research Center estimates of permanent residents was distributed proportionally among residential buildings based on building area. Estimates for every incorporated community, as well as the entire county, were available from the PSU data (**Figure 2-5**). We did not examine the impacts of natural hazards on nonpermanent populations (e.g., tourists), whose total numbers fluctuate seasonally. Due to lack of information within the assessor and census databases, we cannot distinguish between vacation homes and primary residences. Therefore, our method distributes some of the permanent residents into possible vacation homes.

From the PSU Population Research Center data, we assessed the risk of the 131,984 residents within the study area. For each natural hazard, except for the earthquake scenarios, a simple exposure analysis was used to find the number of potentially displaced residents within a hazard zone. For the earthquake scenarios the number of potentially displaced residents was based on residents in buildings estimated to be significantly damaged by the earthquake.

Figure 2-5. Population by Linn County community.



3.0 ASSESSMENT OVERVIEW AND RESULTS

In this risk assessment, we considered six natural hazards (earthquake, flood, landslide, channel migration, wildfire, and volcanic lahar) that pose a risk to Linn County. The assessment describes both localized vulnerabilities and the widespread challenges that affect all communities. While results of this risk assessment do not typically represent singular hazard events, they do quantify the potential overall level of risk for assets and residents. The loss estimation and exposure results, as well as the rich dataset and map plates included with this publication, can lead to greater understanding of the potential consequences of natural disasters. Communities can become more resilient to future disasters by utilizing the results in plan updates and developing future action items for risk reduction.

In this section, results are presented for the entire study area. The study area includes the entirety of Linn County. Individual community results are in **Appendix A: Community Risk Profiles.**

3.1 Earthquake

An earthquake is a sudden movement of rock along a fault in the earth's crust, which abruptly releases strain that has accumulated over time. This movement produces waves of shaking that spread in all directions. If an earthquake occurs near populated areas, it may cause casualties, economic disruption, and extensive property damage (Madin and Burns, 2013).

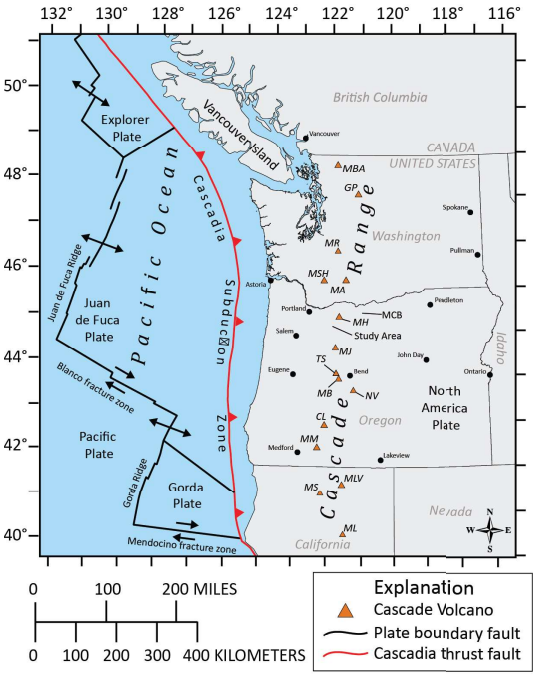
Two earthquake-induced hazards are liquefaction and landslides. Liquefaction occurs when saturated soils substantially lose bearing capacity due to ground shaking, causing the soil to behave like a liquid; this action can be a source of tremendous damage (Kramer, 1996). Coseismic landslides are mass movement of rock, debris, or soil induced by ground shaking. Both of these hazards are site specific and will only occur in locations where conditions permit. All earthquake losses in this report include damages derived from shaking, as well as liquefaction and landslide factors.

This area of northwest Oregon is seismically active, with several historic damaging earthquakes. For example, the Mount Angel Fault is an active fault located near the cities of Mount Angel, Woodburn, and Silverton. On March 25, 1993, a Mw 5.7 earthquake occurred with an epicenter approximately 5 km (3 mi) east of the City of Scotts Mills. Many buildings were damaged from the event, including the Capitol building in Salem. Many unreinforced masonry buildings in the area (e.g., large Catholic cathedrals in Mount Angel and Gervais) were significantly damaged due to intense shaking. The preliminary damage estimate was $28.4 million ($50 million adjusted to 2022 dollars) (Black, 1996).

3.1.1 Scenarios: CSZ and Turner and Mill Creek Fault

Offshore of Oregon's coastline, the Juan de Fuca tectonic plate slides under the North America plate. Oregon (along with the rest of the Pacific Northwest and the nation) sits on the North America plate. This area of interaction between the two plates is known as the CSZ. The pressure and friction created by this convergent motion builds potential energy at the plate boundary until the overriding plate (North America) suddenly slips, releasing energy that manifests as strong shaking spread over a wide area (**Figure 3-1**). Earthquakes as large as Mw 8–Mw 9 occur along the CSZ on average every 230 years–540 years and scientists estimate a 16%–22% chance of one happening in the next 50 years (Goldfinger and others, 2012, 2017).

Figure 3-1 CSZ plate interaction

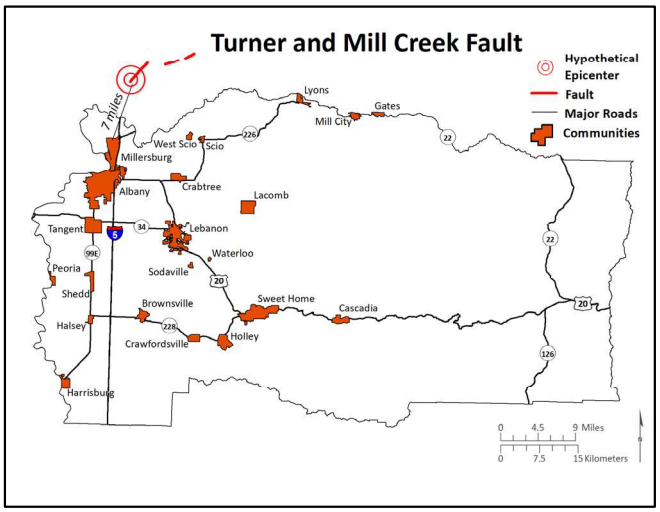


The other scenario examined for this report is an earthquake focused on the Quaternary Turner and Mill Creek Fault (**Figure 3-2**). This east-west-oriented crustal fault is located approximately 10 mi (16 km) northeast of Albany and is mapped for 11 mi (18 km) between Interstate 5 (mile marker 244) and Highway 22 at Aumsville. It has an estimated slip rate less than 0.2mm/yr (0.008in/yr) (Personius, 2002 and citations therein). Unlike the CSZ, which is a very large and deep fault between two tectonics plates, the Turner and Mill Creek Fault is a crustal fault. Such planar fractures occur in the Earth's crust where rocks are displaced relative to one another. Despite their comparatively small size, crustal earthquakes can cause significant damage due to their proximity to the surface and the built environment.

The estimated maximum fault displacement for the Turner and Mill Creek Fault could produce relatively large (Mw 6.6) earthquakes, enough to pose a significant hazard (Personius, 2002). The current understanding of this fault and various aspects of its frequency and magnitude are limited.

We examined earthquake shaking and ground failure hazards produced from both earthquake scenarios in Hazus to encapsulate the range of damages from two very different kinds of earthquakes: a nearby crustal earthquake focused on the Turner and Mill Creek Fault and a more distant and very large-magnitude earthquake focused on the CSZ.

Figure 3-2. Turner and Mill Creek Fault location



According to the National Seismic Hazard Map (Frankel and others, 2000), 75% of earthquake risk is due to a CSZ-related earthquake; in comparison, a crustal earthquake makes up 4% of the earthquake risk. The remaining risk is from an earthquake with focal mechanisms in the subducting slab of the CSZ. The effects from either earthquake scenario present a challenge for planners preparing for hazard impacts.

3.1.2 Data sources: CSZ

Most of the hazard data inputs for our Hazus earthquake analysis were originally created for the Oregon Seismic Hazard Database, release 1.0 (OSHD-1), which included ground shaking and site-specific data (coseismic landslide, liquefaction, and soil amplifaction) for a CSZ Mw 9.0 event (Madin and others, 2021). Wirth and others (2021) ran 30 CSZ Mw 9.0 simulations that represented the variability of shaking using ground shaking datasets developed by Madin and others (2021) for OSHD-1. At the time of writing, these are the most up to date earthquake simulations and site-specific data.

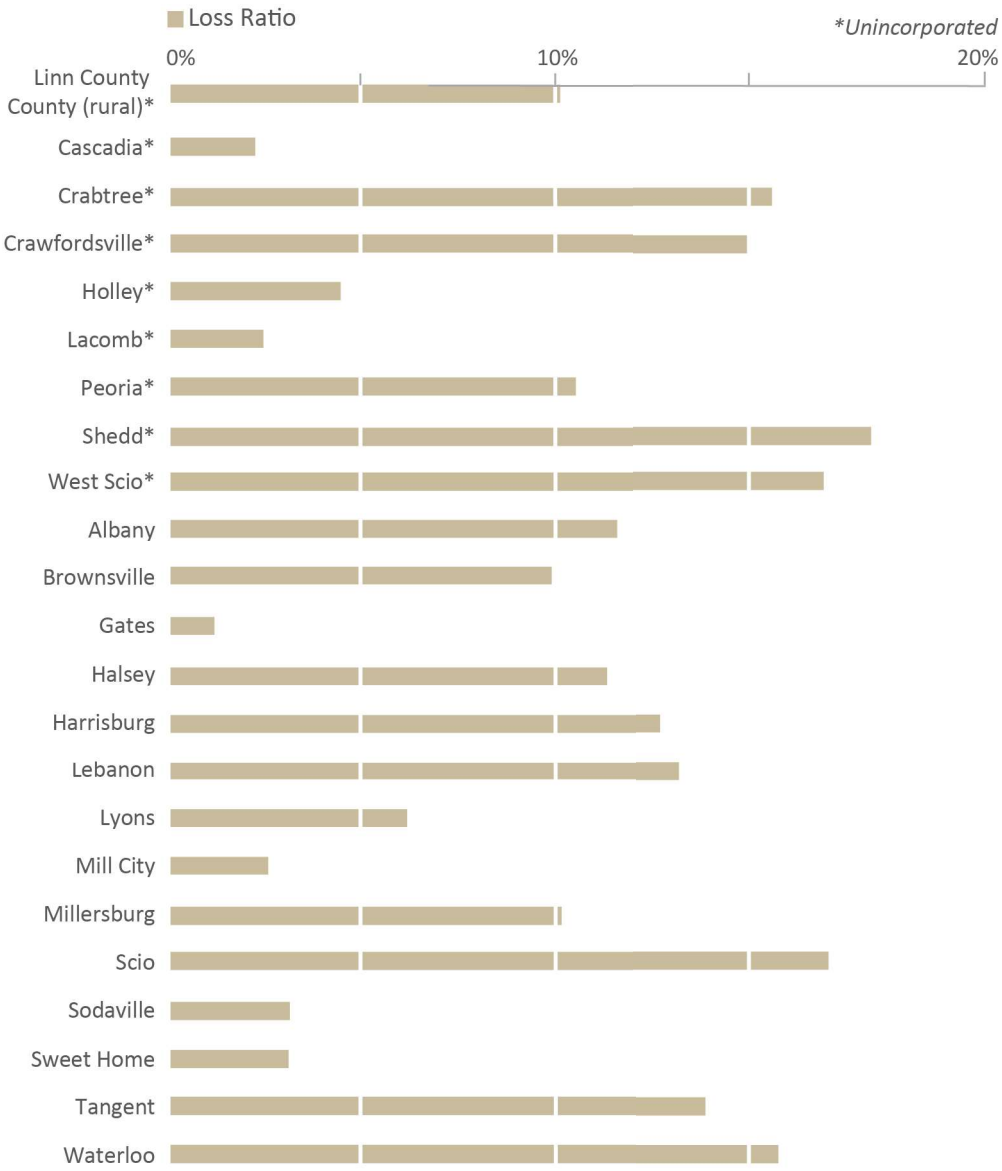
Hazus offers two methods for estimating loss from earthquake: probabilistic and deterministic (FEMA, 2012b). A probabilistic scenario uses USGS National Seismic Hazard Maps, which are derived from seismic hazard curves calculated on a grid of sites across the United States that describe the annual frequency of exceeding a set of ground motions as a result of all possible earthquake sources (USGS, 2017). A deterministic scenario is based on a specific seismic event, which in this case is the CSZ Mw 9.0 event. We selected the deterministic scenario method because the CSZ event is the most likely large earthquake to impact this area (Goldfinger and others, 2012, 2017). We used the deterministic method along with the UDF database so that loss estimates could be calculated on a building-by-building basis.

The following hazard layers used for the loss estimation analysis are derived from work conducted by Madin and others (2021): National Earthquake Hazard Reduction Program (NEHRP) soil classification, peak ground acceleration (PGA), peak ground velocity (PGV), spectral acceleration at 1.0 second period and 0.3 second period (SA10 and SA03), liquefaction susceptibility, and landslide susceptibility. The liquefaction and landslide susceptibility layers together with PGA were used by the Hazus tool to calculate the probability and magnitude of permanent ground deformation.

3.1.3 Countywide results: CSZ

Because an earthquake can affect a wide area, every building in Linn County will be shaken by a CSZ Mw 9.0 earthquake. Hazus loss estimates (see **Table B-2)** for each building are based on a formula where coefficients are multiplied by each of the five damage state percentages (i.e., none, slight, moderate, extensive, and complete). These damage states are correlated to loss ratios that are then multiplied by the total building replacement value to obtain a loss estimate (FEMA, 2022b). Loss estimates from the CSZ earthquake scenario are presented in **Figure 3-3**.

Figure 3-3. CSZ Mw 9.0 earthquake loss ratio by Linn County community.



In keeping with earthquake-damage reporting conventions, we used the Applied Technology Council (ATC-20) post-earthquake building safety evaluation color-tagging system to represent damage states (Applied Technology Council, 2015). Red-tagged buildings correspond to a Hazus damage state of "complete," which means the building is uninhabitable. Yellow-tagged buildings are in the "extensive"

damage state, indicating limited habitability. The number of red or yellow-tagged buildings we report for each community is based on an aggregation of the probabilities for individual buildings (FEMA, 2022b).

Critical facilities were considered nonfunctioning if the Hazus earthquake analysis showed that a building or complex of buildings had a greater than 50% chance of being at least moderately damaged (FEMA, 2022b). Because building specific information is more readily available for critical facilities and they are of higher importance after a disaster, we chose to report the results of these buildings individually.

The number of potentially displaced residents from our CSZ Mw 9.0 earthquake scenario was based on the formula (FEMA, 2022b): ([Number of Occupants] * [Probability of Complete Damage]) + (0.9 * [Number of Occupants] * [Probability of Extensive Damage]).

The results indicate that Linn County could incur moderate to significant losses (10%) due to a CSZ Mw 9.0 earthquake. Most of the communities in Linn County can expect approximately 10% to 16% of damage from a CSZ event. Much of the anticipated damage is due to liquefaction and soils that amplify seismic shaking. The Willamette River and Santiam River floodplains are composed of liquefiable soils where the majority of the buildings in Linn County are located. Since these unconsolidated sediments and soils amplify ground shaking, the probability of earthquake damage is greater for structures built in these areas.

Linn County CSZ Mw 9.0 earthquake results:

- Number of red-tagged buildings: 2,612
- Number of yellow-tagged buildings: 11,488
- Loss estimate: $2,637,395,000
- Loss ratio: 10%
- Non-functioning critical facilities: 33 of 154
- Potentially displaced population: 5,263

Although damage caused by coseismic landslides was not specifically looked at in this report, it likely contributes to the estimated damage from earthquake hazard in Linn County. Landslide exposure (not to be confused with coseismic landslide analysis) results show that 5.5% of buildings in Linn County are within a Very High or High susceptibility zone. We infer that a similar percentage of the total earthquake losses estimated in this study may be due to coseismic landslide activity.

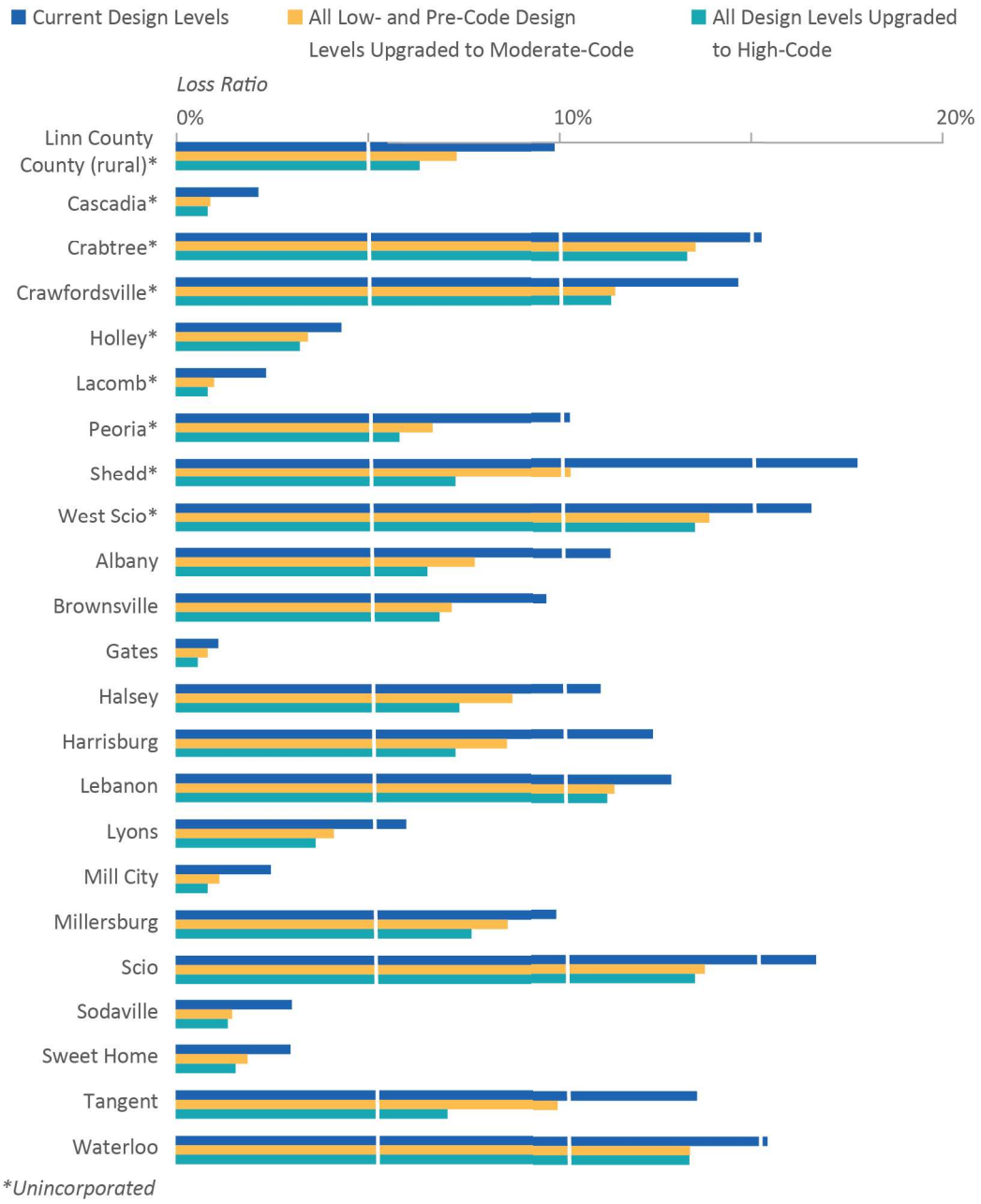
Aging building stock and certain occupancy types are also contributing factors in loss estimates. The first seismic buildings codes were implemented in Oregon in the 1970s (Judson, 2012) and by the 1990s modern seismic building codes were being enforced. Nearly 45% of Linn County's buildings were built before the 1990s. In Hazus, manufactured homes are one occupancy type that performs poorly in earthquake damage modeling. Communities that are composed of an older building stock and more vulnerable occupancy types are expected to experience more damage from earthquake than communities with fewer of these vulnerabilities.

If Pre-code and Low-code buildings could be seismically retrofitted to higher code standards, earthquake risk would be greatly reduced. In this study, a simulation in Hazus earthquake analysis shows that loss ratios drop from 10% to 7%, when all Pre-code and Low-code buildings are upgraded to at least Moderate-code level. While retrofits can decrease earthquake vulnerability, for areas of High landslide or liquefaction susceptibility, additional geotechnical mitigation may be necessary to have a significant effect on losses. Two Hazus simulations of a CSZ Mw 9.0 earthquake where all Pre-code and Low-code buildings are upgraded to Moderate-code and High-code standards show significant reductions in losses (**Figure 3-4**).

Key Terms:

- *Seismic retrofit:* Structural modification to a building that improves its resilience to earthquake.
- *Design level:* Hazus terminology referring to the quality of a building's seismic building code (i.e., Pre, Low, Moderate, and High). Refer to **Appendix C.2.3** for more information.

Figure 3-4. CSZ Mw 9.0 earthquake loss ratio in Linn County, with simulated seismic building code upgrades.



3.1.4 Data sources: Turner and Mill Creek Fault scenario

The Turner and Mill Creek Fault deterministic Mw 6.6 earthquake scenario was selected as the most appropriate for communicating the crustal earthquake risk for Linn County because of the indication of late Quaternary activity and the fact that its location is moderately constrained (Personius, 2002). The default Hazus earthquake scenario database contained the location and geometry of the fault and

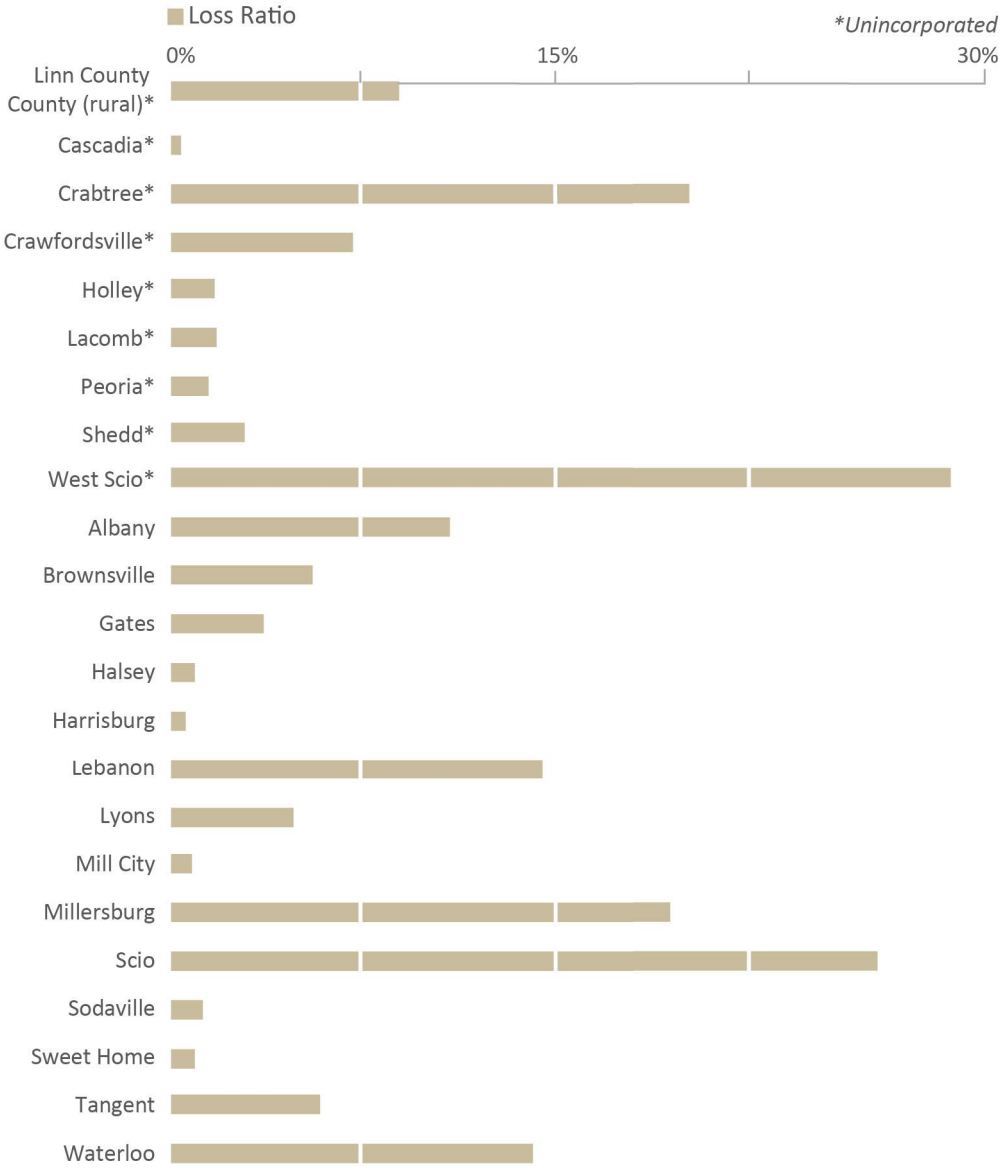
recommends a maximum magnitude for a potential event. The hypothetical epicenter was manually selected and was located at the closest proximity to buildings within the study area.

The following hazard layers used for our loss estimation were sourced from work conducted by Madin and others (2021): NEHRP soil classification, landslide susceptibility (wet), and liquefaction susceptibility. The liquefaction and landslide susceptibility layers were used by the Hazus tool to calculate the probability and magnitude of permanent ground deformation caused by these factors. Hazus uses a characteristic magnitude value to calculate the impacts of liquefaction and landslides. For this study, we used Hazus defaults, including a Mw 6.6 scenario as the characteristic event.

3.1.5 Countywide results: Turner and Mill Creek Fault scenario

While a CSZ event will cause substantial widespread damage throughout the entire study area, our results indicate a Turner and Mill Creek Fault Mw 6.6 earthquake will cause significant damage (15%–30% in losses) to primarily areas in the northwest portion of the county. Because an earthquake can affect a wide area, it will also cause damage in the other communities in Linn County, but to a lesser degree. Ground deformation (coseismic liquefaction and landslides) are also determining factors in damage results for this earthquake scenario. **Figure 3-5** shows loss ratios from this earthquake scenario for the communities of Linn County.

Figure 3-5. Earthquake loss ratio from Turner and Mill Creek Fault Mw 6.6 by Linn County community.



The results indicate that Linn County could incur losses near $2.4 billion (8.8% of their total building assets) from a Turner and Mill Creek Fault Mw 6.6 earthquake. These results are strongly influenced by the proximity of buildings to the epicenter of the simulated earthquake. Communities in the northwestern portion of the county are not only close to the epicenter, but also are in areas of highly liquefiable soils. In addition to proximity, liquefaction exacerbates the level of risk from this earthquake scenario for the communities in this part of the county. We reviewed the risk assessment results in ArcMap™ and observed that residential buildings in Albany and commercial buildings in Millersburg in the area where Truax Creek flows into the Willamette River have a high risk of damage from this earthquake due to liquefaction hazard. Other areas that are at risk from this earthquake are along the South Santiam River, which includes the communities of Crabtree and Lebanon. Communities along Thomas Creek, including the communities of Scio and West Scio, are at much greater risk from this earthquake than other communities in Linn County. Keep in mind that these results are based on a hypothetical epicenter location. A Mill

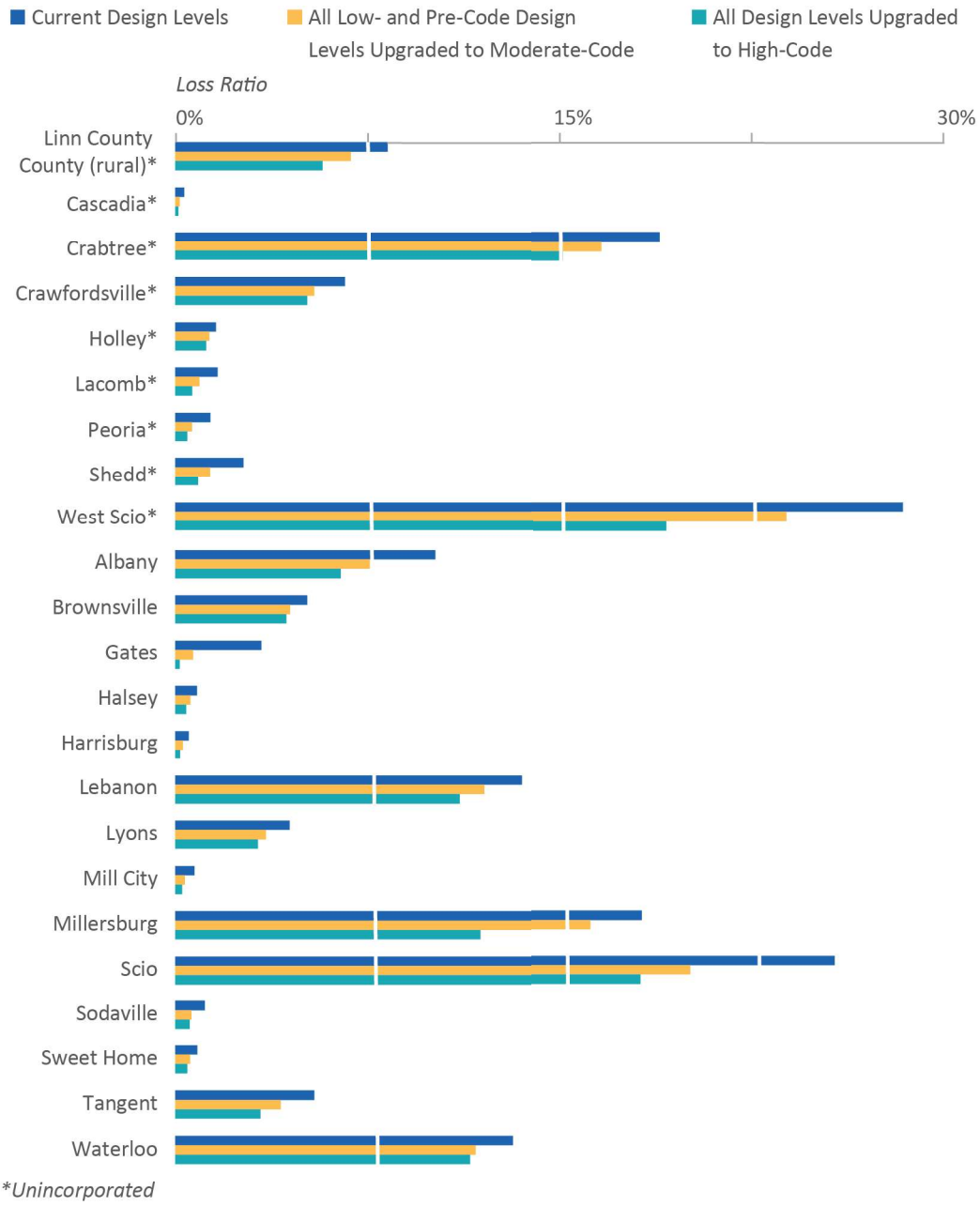
Creek and Turner Fault earthquake with a different rupture location will cause different levels of damage in the communities of northwest Linn County.

Linn County Turner and Mill Creek Fault Mw 6.6 earthquake results:

- Number of red-tagged buildings: 2,749
- Number of yellow-tagged buildings: 8,942
- Loss estimate: $2,369,796,000
- Loss ratio: 8.8%
- Nonfunctioning critical facilities: 34 of 154
- Potentially displaced population: 5,286

As with the CSZ earthquake hazard, if buildings could be seismically retrofitted to Moderate-code or High-code standards, the impact of this event would be greatly reduced. In a simulation by DOGAMI, a Hazus earthquake analysis shows that loss estimates drop from 8.8% to 7.2% when all buildings are brought up to at least Moderate-code level. Although these upgrades can decrease earthquake vulnerability, the benefits are minimized in landslide and liquefaction areas, where buildings would need additional geotechnical mitigation to have a significant effect on losses. **Figure 3-6** illustrates the reduction in loss estimates from a Turner and Mill Creek Fault Mw 6.6 earthquake through two simulations where all buildings are upgraded to at least Moderate-code standards and then to High-code standards.

Figure 3-6. Turner and Mill Creek Fault Mw 6.6 earthquake loss ratio in Linn County, with simulated seismic building code upgrades



3.1.6 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk to earthquake hazard:

- A large High liquefaction zone east of Albany that includes the community of Crabtree and parts of Lebanon will increase the likelihood of damage in that area from an earthquake produced from the CSZ or the Turner and Mill Creek Fault.
- High liquefaction areas on the Willamette River and Mill Creek floodplains will increase the likelihood of damage from an earthquake.

- Unreinforced masonry buildings in the older downtown portions of Albany, Millersburg, Lebanon, and Sweet Home are more vulnerable to substantial damage during an earthquake, compared to other nearby structures built to modern standards.
- 35 of the 154 critical facilities in the study area are estimated to be nonfunctioning following a CSZ earthquake like the one simulated in this study and 34 are estimated to be nonfunctioning due to a Turner and Mill Creek Fault earthquake.

3.2 Flooding

The frequency and severity of flooding may change over time due to changes in land use (e.g., development, waterways, and watershed management), as well as natural phenomenon such as precipitation patterns and changes in climate. This study represents our current understanding of flood hazards and flood risk, but we recognize that flood models and risk assessments will need to be updated with changing conditions.

In its most basic form, a flood is an accumulation of water over normally dry areas, typically due to excessive rain or snowmelt. Floods become hazardous to people and property when they inundate an area where development has occurred, causing losses. Floods are a commonly occurring natural hazard in Linn County and have the potential to create public health hazards and public safety concerns, close and damage major highways, destroy railways, damage structures, and cause major economic disruption. More rare flood issues such as flash flooding, ice jams, post-wildfire floods, and inundation due to a dam breach were not examined in this report.

A typical method for determining flood risk is to identify the probability of a given size occurring and the impacts of flooding, primarily inundation extents and depth. The annual probabilities calculated for flood hazard used in this report are 10%, 2%, 1%, and 0.2%, henceforth referred to as 10-year, 50-year, 100-year, and 500-year scenarios, respectively. The ability to assess the probability of a flood occurring, and the level of accuracy of that assessment is influenced by modeling advancements, better understanding of hydrologic factors, and longer periods of record for the stream or water body in question.

The major rivers and creeks within the county are the Calapooia, North Santiam, South Santiam, and Willamette rivers and Ames, Cox, Crooks, Oak, Truax, and Thomas creeks. In addition, there are several tributaries to these major streams that have mapped flood zones. All the mapped streams are subject to flooding and can cause damage to buildings in the floodplain.

Within the last 60 years there have been several major floods of note for Linn County, two of these floods affected large areas and many communities. In December 1964 heavy rainfall on snow occurred that caused historic flooding on the Calapooia, North Santiam, Santiam, and Willamette rivers and Thomas and Ames creeks. This flooding caused damage to the communities of Albany, Jefferson, Scio, Sweet Home, and Cascadia. Flooding would have been much worse were it not for flood reduction measures, primarily upstream of Linn County communities, such as flood storage areas along the Willamette River and the Detroit Dam. Other notable floods occurred in 1966 and 1974 along Ames Creek, which caused damage in the City of Sweet Home and surrounding areas (FEMA, 2016).

The consequences of flooding are determined by adverse effects to human activities within the natural and built environment, such as the destruction of homes and displacement from residences. These adverse conditions can be reduced through mitigation efforts, such as elevating structures above the

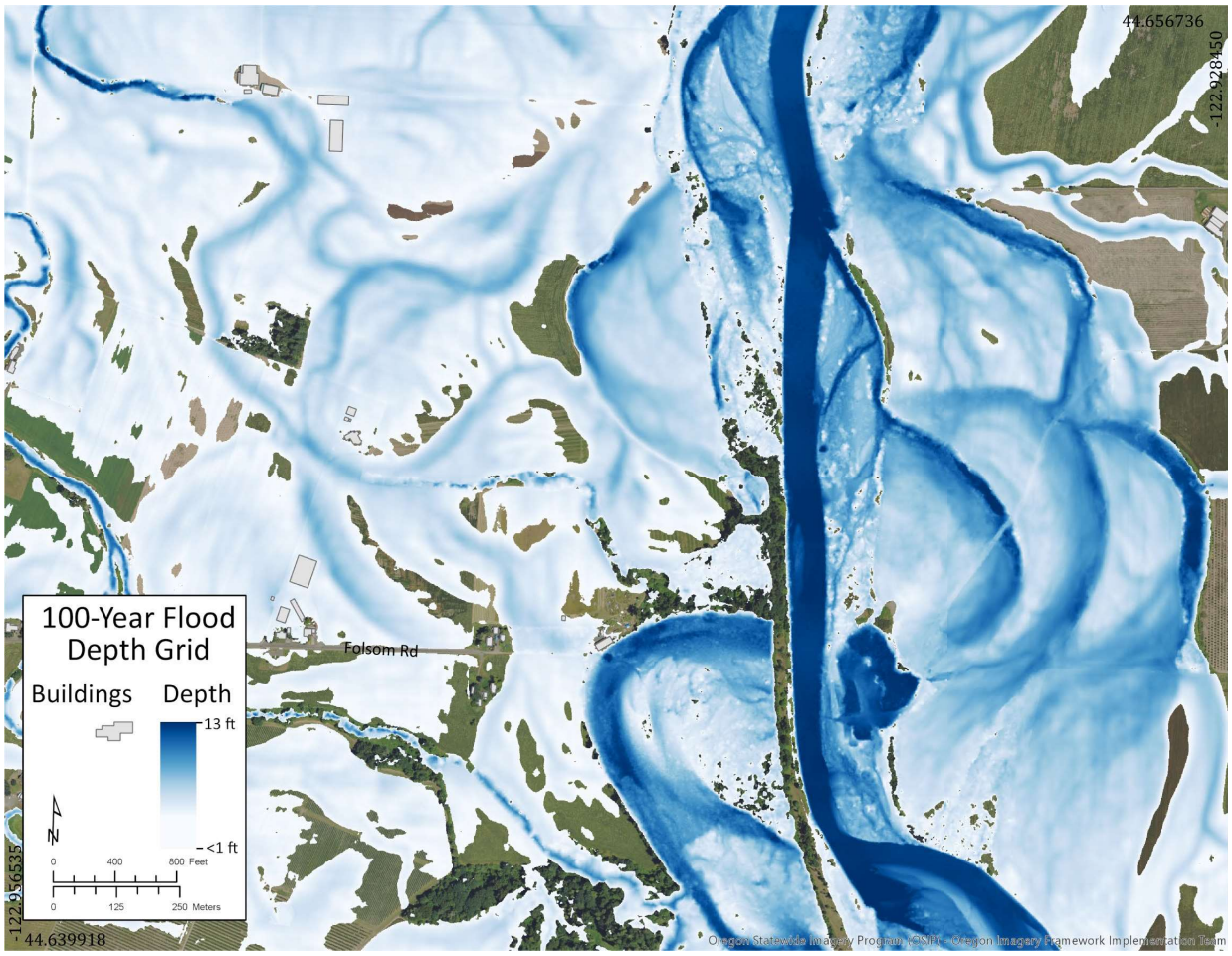
expected level of flooding, removing structures through FEMA's property acquisition (buyout) program, or land use planning that considers risk from flooding.

3.2.1 Data sources

The Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for Linn County were updated in 2016 (FEMA, 2016); this was the primary data source for this flood risk assessment. This data source was adopted in 2016 by Linn County to regulate flood zones. Further information regarding the National Flood Insurance Program (NFIP) is on the FEMA website: https://nfipservices.floodsmart.gov/reports-flood-insurance-data. While no place is completely risk-free from flood hazard, this was the only flood data source that was available for this analysis.

DOGAMI developed depth grids for four riverine flooding scenarios (10, 50, 100, and 500 year) from detailed stream information and high-resolution lidar collected in 2009 and 2012 (Willamette Valley 2009 project and Central Coast 2012 project - Oregon Lidar Consortium; see http://www.oregongeology.org/lidar/collectinglidar.htm). Depth grids are raster GIS datasets in which each digital pixel value represents the depth of flooding at that location (**Figure 3-7**). They were used in this risk assessment to determine the level to which buildings could be impacted by flooding through loss estimation and exposure analyses.

Figure 3-7. Flood depth grid example along the Willamette River in rural Linn County, Oregon.



Note: The deepest depths (dark-blue) indicate the current position of the Willamette River.

Building loss estimates are determined in Hazus by overlaying building data on a depth grid. Hazus uses individual building information, specifically the first-floor height above ground and the presence of a basement, to calculate the loss ratio from a particular depth of flood.

For Linn County, occupancy type and basement presence attributes were available from the assessor database for most buildings. Where individual building information was not available from assessor data, we used street level imagery to estimate these important building attributes. Only buildings in a flood zone or within 500 ft (152 m) of a flood zone were examined in this manner. Because our analysis accounted for building first-floor height, buildings that have been elevated above the flood level were not given a loss estimate—but we did count residents in those structures as displaced. We did not look at the duration that residents would be displaced from their homes due to flooding. For information about structures exposed to flooding but not damaged, see the **Exposure analysis** section.

3.2.2 Countywide results

For this risk assessment, we imported the countywide UDF data and depth grids into Hazus and ran a flood analysis for four scenarios (10, 50, 100, and 500 year). We used the 100-year flood as the primary scenario for reporting results. The 100-year flood has traditionally been used as a reference level for flooding and is the standard probability that FEMA uses for regulatory purposes. See **Table B-4** for multi-scenario cumulative results.

Linn Countywide 100-year flood loss:

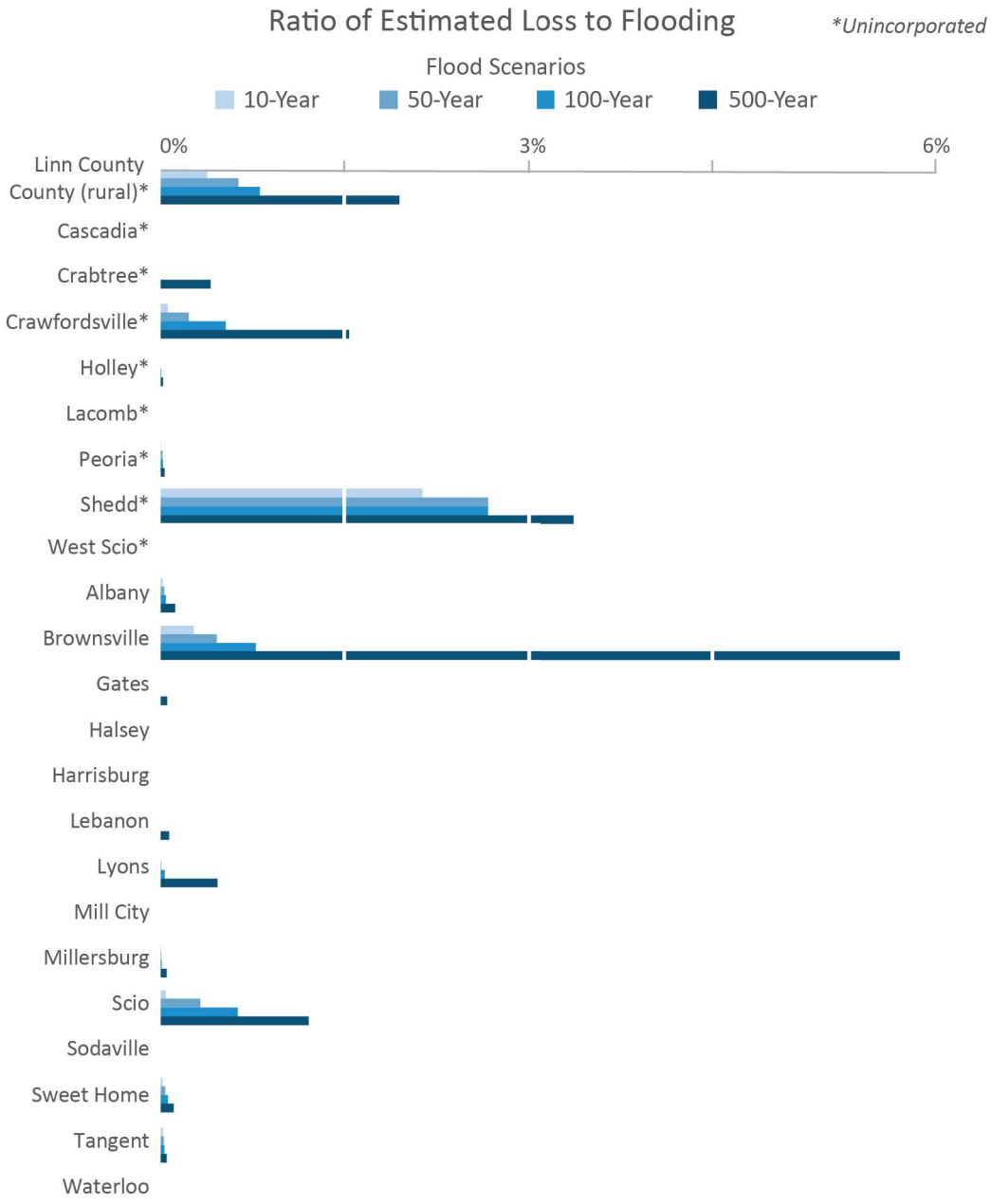
- Number of buildings damaged: 1,973
- Loss estimate: $99,287,000
- Loss ratio: 0.4%
- Damaged critical facilities: 3 of 154
- Potentially displaced population: 1,917

3.2.3 Hazus analysis

The countywide loss estimate for the 100-year flood scenario is nearly $100 million. While the loss ratio of flood damage for the entirety of Linn County is 0.4%, the impact to developed areas near flood-prone streams is significant, specifically Brownsville and Shedd (**Figure 3-8**). In communities where most residents are not within flood zones, the loss ratio may not be as helpful as the actual replacement cost and number of residents displaced to assess the level of risk and impact from flooding. The Hazus analysis also provides useful information for individual communities so that planners can identify problems and consider which mitigation activities will provide the greatest resilience to flooding.

The main flooding problems within Linn County are primarily in the areas of Brownsville, Scio, Crawfordsville, and Shedd. The unincorporated county also has a high level of estimated damage from the major streams and their tributaries that flow through the county (**Figure 3-8**). There are few specific areas in Linn County where a cluster of buildings are all at risk from flood. The small amount of damage that is estimated is scattered across the county at various places along the mapped streams.

Figure 3-8. Ratio of flood loss estimates by Linn County community.



3.2.4 Exposure analysis

For comparison purposes, we performed a separate exposure analysis in addition to the Hazus loss estimation. By overlaying building locations on the 100-year flood zone, we can calculate the number of buildings that are elevated above the level of flooding and estimate the number of displaced residents. This was done by comparing the number of nondamaged buildings from Hazus with the number of exposed buildings in the flood zone. A small proportion (2.4%) of Linn County's buildings were found to be within designated flood zones. Of those 2,246 buildings, we estimate that 273 are above the height of the 100-year flood. This evaluation also estimates that 1,917 residents might have mobility or access

issues due to being surrounded by rising floodwaters. See **Appendix B: Table B-5** for community-based results of flood exposure.

3.2.5 Dam safety

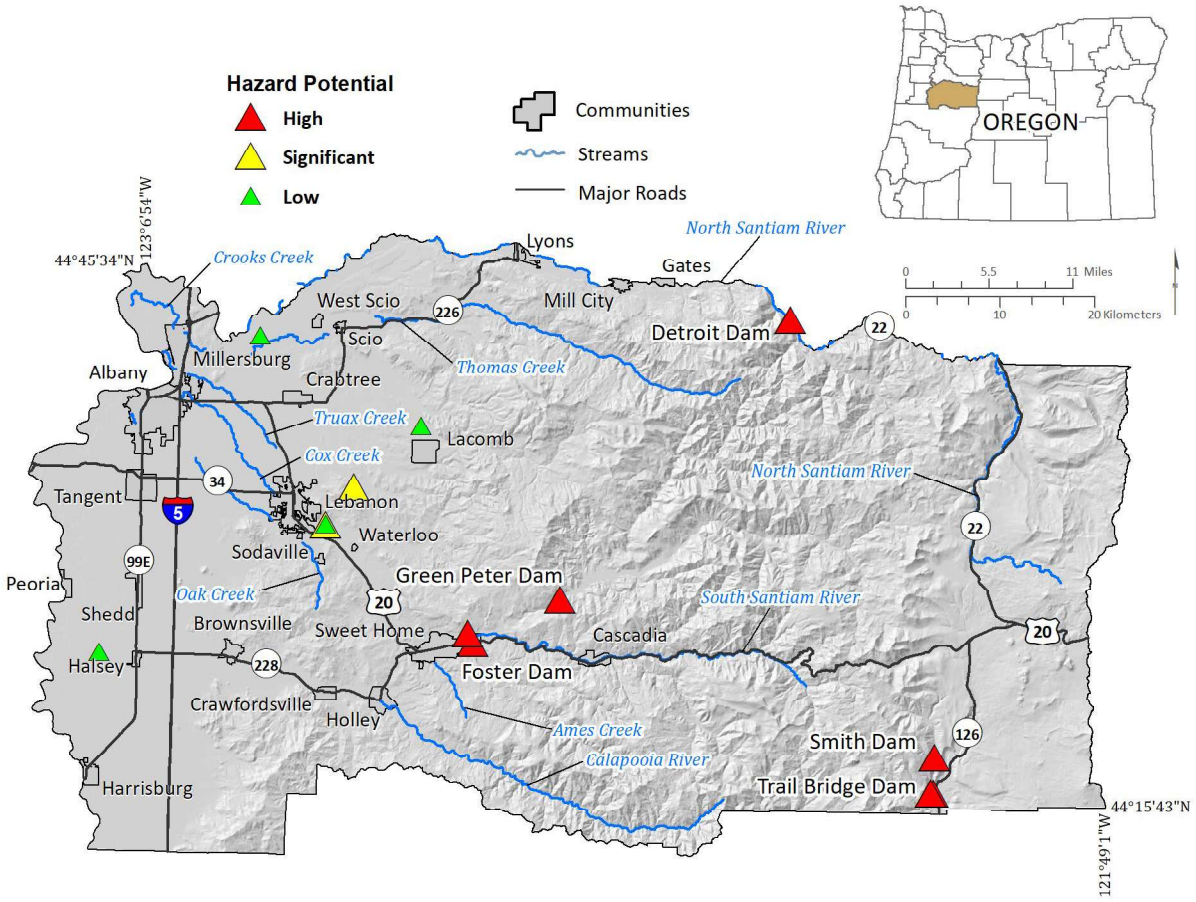
Dam safety is highly important when considering flood hazards. Dams are crucial structures designed to store and control water flow, but their failure can lead to catastrophic consequences during periods of heavy rainfall and flooding. Ensuring the safety of dams involves rigorous monitoring, regular inspections, and maintenance procedures. Structural integrity is a key concern, as any weaknesses or deficiencies in the dam's construction could be exacerbated by the force of floodwaters, potentially leading to a breach. Thus, it is crucial to implement stringent engineering standards and employ advanced technologies to assess the stability and reliability of dams, especially in flood-prone areas. Regular evaluation of spillways, embankments, and foundation conditions is necessary to identify potential risks and promptly address them to minimize the likelihood of dam failure during floods.

In addition to structural considerations, dam safety also encompasses effective flood management strategies. This includes establishing comprehensive flood forecasting and warning systems to provide timely alerts to downstream communities and emergency responders. Such systems rely on real-time data collection and analysis, which enables authorities to anticipate flood events and take appropriate actions. Regular communication and coordination among dam operators, local authorities, and the public are vital to ensure that evacuation plans and emergency protocols are in place and well understood. By implementing a holistic approach to dam safety, including both structural integrity and effective flood management, the risks associated with flood hazards can be minimized, protecting lives and infrastructure in flood-prone regions.

The U.S. Army Corps of Engineers (USACE) dam inventory is a large dataset of most of the dams in the United States and its territories. The dataset allows users to download specific information about dams for a specific location. The type, size, function, and hazard potential, among other details, are available from the dam inventory. The USACE first published a dam inventory in 1975 and since that time has continued to develop the dam inventory dataset.

DOGAMI used the USACE dam inventory to identify specific dams that were considered to be at a potentially High, Significant, or Low risk from a natural hazard impact perspective. Meaning, in the event of a dam failure or breach, there would be a potential for loss of life or other significant damage. There are 14 dams in Linn County that serve several functions, including agricultural, hydroelectric, water supply, and flood reduction (**Appendix Table B-6**). Seven of those dams are considered high hazard, including the largest three dams that are operated by the USACE: Green Peter Lake, Detroit, and Foster dams (**Figure 3-9**). These dams were primarily built as flood control structures. Green Peter Dam is on the Middle Santiam River and forms the Green Peter Reservoir, which is located 9.7 km (6 mi) northeast of Sweet Home. Detroit Dam forms Detroit Lake, which is used for numerous recreational activities; it is located along the North Santiam River and is 12.9 km (8 mi) upstream of the City of Gates. The third high hazard dam operated by the USACE is Foster Dam, which is located in the City of Sweet Home. Foster Dam is built on the confluence of the South Santiam River and Middle Santiam River and forms the Foster Reservoir.

Figure 3-9. Dams in Linn County.



3.2.6 Future conditions: flood hazard

Climate change has had a significant impact on flood hazards around the world, exacerbating the frequency, intensity, and magnitude of flooding events (OCCRI, 2023). The interplay between climate change and flood hazards is a complex phenomenon influenced by various factors such as rising temperatures, changing precipitation patterns, and altered hydrological cycles caused by warmer air holding more water vapor. These changes have a wide range of consequences for human populations, ecosystems, and infrastructure (OCCRI, 2023).

According to the report examining climate projections by OCCRI (2023), climate change will influence changes to flood hazard in Linn County. Predictive models indicate an increase in winter runoff levels and lower runoff during the summer and fall months. Winter flooding is projected to increase due to rain-on-snow occurrences as average winter temperatures increase. Warmer average temperatures, more extreme storms, including atmospheric rivers, and an increase in the proportion of precipitation falling as rain instead of snow all will contribute to an increase of flood risk in Linn County.

3.2.7 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk of flood hazard:

- Many farms and residential structures south of Stayton (Marion County) are built within the floodplain of the Santiam River.
- Many buildings are at risk from flooding along Thomas Creek in the City of Scio.
- Flood risk is present in areas along the Willamette River, Mill Creek, and the South Santiam River.

3.3 Landslide Susceptibility

Landslides are mass movements of rock, debris, or soil down a slope. Landslides can occur in many sizes, at different depths, and with varying rates of movement. Generally, they are large, deep, and slow moving or small, shallow, and rapid. Factors that influence landslide type include slope steepness, water content, and underlying geology. Many triggers can cause a landslide: intense rainfall, earthquakes, or human-induced factors like water concentration, excavation along a landslide toe or loading at the top. Landslides can cause severe damage to buildings and infrastructure. Fast-moving landslides may pose life safety risks and can occur throughout Oregon (Burns and others, 2016). The most common landslide types in Clackamas County are debris flows and shallow- and deep-seated landslides.

Because landslides are a site-specific hazard that occur over much smaller spatial extents than most other natural hazards, measuring the risk associated with future landslides for a large area can be difficult. Landslide susceptibility measures the likelihood that a given location will experience a landslide in the future based on a variety of factors including slope, geology, soil type, and the presence of preexisting landslides.

This study represents our current understanding of landslide susceptibility to measure the risk in Linn County. However, changing climate, precipitation patterns, land use, wildfire events, and land and forest management strategies may increase or decrease the susceptibility to landslides.

3.3.1 Data sources

We used the data from the Statewide Landslide Susceptibility Map (Burns and others, 2016), which derives from multiple datasets created using methods outlined in DOGAMI Special Paper 42 (Burns and Madin, 2009).

Burns and others (2016) used the Statewide Landslide Information Database for Oregon (SLIDO) along with maps of generalized geology and slope to create a landslide susceptibility overview map of Oregon that shows zones of relative susceptibility: Very High, High, Moderate, and Low. Mapped landslides from SLIDO data directly define the Very High susceptibility zone, while SLIDO data coupled with statistical results from generalized geology and slope maps define the other relative susceptibility zones (Burns and others, 2016).

SLIDO, release 3.2 (Burns and Watzig, 2014) is an inventory of mapped landslides in the state of Oregon and was used to create the Statewide Landslide Susceptibility Map. These data have the inherent limitations of SLIDO as well as the generalized geology and slope maps, namely differing levels of accuracy and resolution. Therefore, the statewide landslide susceptibility map varies significantly in scale across the state and care should be taken when using the data. Another limitation is that susceptibility mapping does not include some aspects of landslide hazard, such as runout, where the momentum of the landslide can carry debris beyond the zone deemed to be High hazard.

The most recent landslide mapping in SLIDO for Linn County was published in 2010 (western half of Linn County) (McClaughry and others, 2010) and 2002 (eastern half of Linn County) (compiled in Franczyk and others, 2021). The lack of lidar-based landslide mapping means the statewide landslide

susceptibility layer in Linn County relies more heavily on modeled slope and generalized geology. The scale of mapping in much of Linn County is considered the "least detail[ed]", meaning smaller than 1:62,500 map scale. The portion within the Willamette Valley, however, is considered to be more detailed, with scales between 1:8,000 to 1:62,500.

We used data from Burns and others (2016) in this report to identify the general level of susceptibility of a given area to landslide hazards, primarily shallow and deep landslides. We overlaid building and critical facilities data on landslide susceptibility zones to assess the exposure for each community (see **Appendix B: Table B-6**). The following section presents the estimated total dollar value of exposed buildings, and the number of people potentially threatened by landslides. Land value losses due to landslides and potentially hazardous unmapped areas that may pose real risk to communities were not examined for this report.

3.3.2 Countywide results

We found that areas along Route 22 along the North Santiam River have a high level of exposure to landslide hazard. Generally, communities in the central and eastern portion of Linn County that are in terrain with moderate to steep slopes or at the base of steep hillsides are more likely to be exposed to landslides. The percentage of building value exposed to Very High and High landslide susceptibility is approximately 5.5%, which equates to more than 6,700 buildings, with a value approaching $1.5 billion.

We combined High and Very High susceptibility areas as the primary scenarios to provide a general sense of community risk for planning purposes (see **Appendix E: Plate 8**). We determined the best way to communicate the level of landslide risk to communities was by combining the exposure results for both susceptibility zones. The High and Very High susceptibility zones represent areas most susceptible to landslides with the greatest impact to the community.

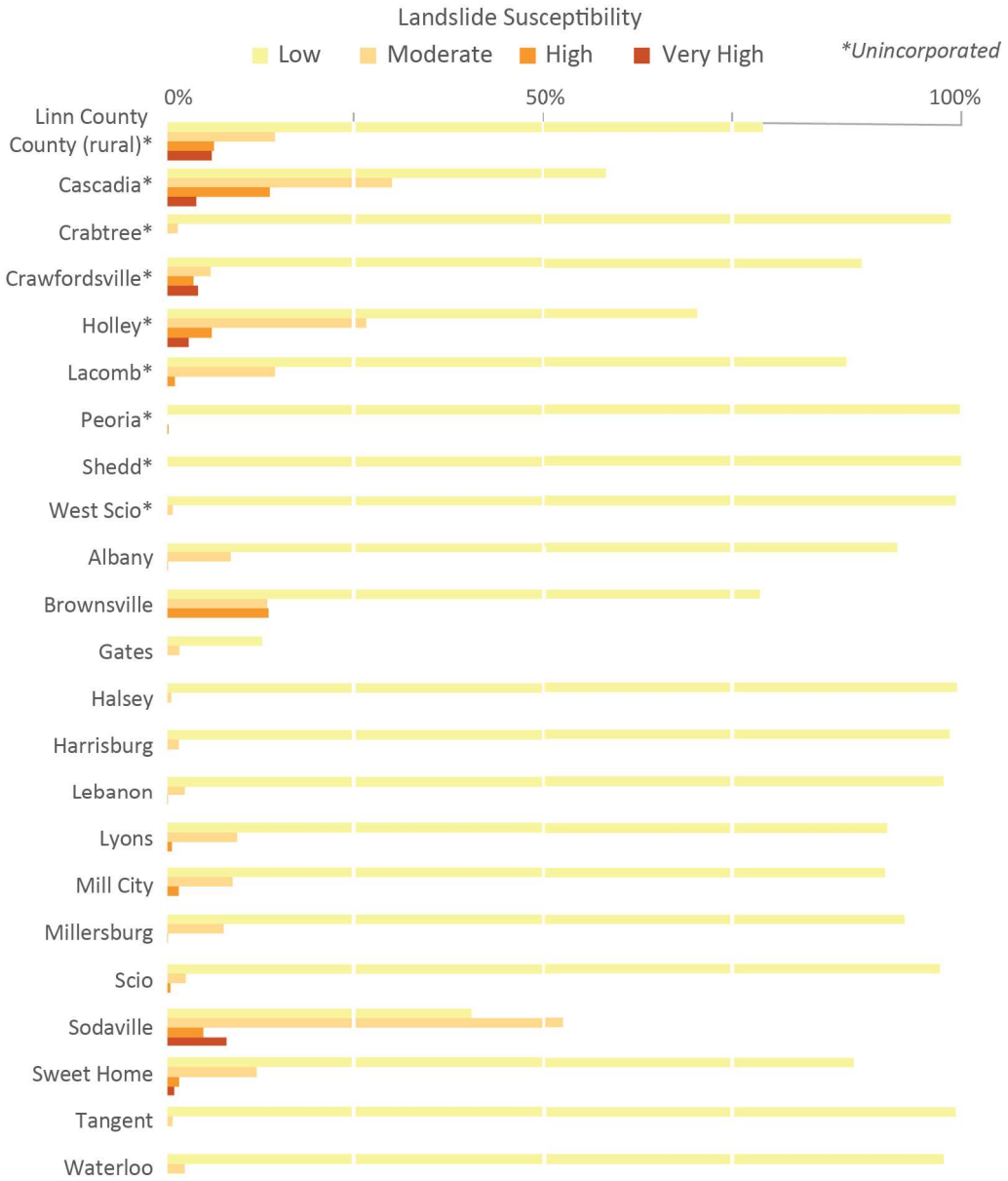
For this risk assessment, we compared building locations to geographic extents of the landslide susceptibility zones (**Figure 3-10**). See **Appendix B: Detailed Risk Assessment Tables** for exposure analysis results of all susceptibility categories.

Linn Countywide landslide exposure (High and Very High susceptibility):

- Number of buildings: 6,759
- Value of exposed buildings: $1,484,804,000
- Percentage of total county value exposed: 5.5%
- Critical facilities exposed: 1 of 154
- Potentially displaced population: 6,047

Most of the developed land in Linn County is located on the low-relief terrain found in the Willamette Valley, which is predominantly classified as having a Low landslide susceptibility. However, there are developed areas in the central part of Linn County where Highway 20 intersects Route 228, in the vicinity of Brownsville, Sodaville, Crawfordsville, and Holley, that are highly susceptible to landslide hazard. Landslide hazard is also ubiquitous in the eastern portion of Linn County, which may present challenges for planning and mitigation efforts. Awareness of nearby areas of landslide hazard is beneficial to reducing risk for every community and rural area of Linn County.

Figure 3-10. Landslide susceptibility exposure by Linn County community.



3.3.3 Future conditions: landslide hazard

Climate change will influence landslide hazards in some landslide-prone areas where an increase in precipitation occurs (OCCRI, 2023). The frequency and magnitude of precipitation events can influence the probability of landslides occurring by saturating soils and prolonging the period in which soils remain saturated. Saturated soil increases landslide risk because saturated soils are heavier, and the presence of water reduces friction in the potential landslide material. In addition, areas that have recently burned are far more susceptible to landslides after heavy rainfall (OCCRI, 2023). Since climate change is also expected to increase the likelihood of wildfire, post-wildfire debris flows are also at a higher chance of occurring.

According to the report examining climate projections by OCCRI (2023), the annual number of days where soil saturation exceeds the threshold for landslide risk is expected to remain the same (31 days) as observed risk days measured from 2010-2022. The projection for landslide risk in Linn County is expected to not increase or decrease due to precipitation rates remaining near the average. However, precipitation is only one factor of several that influence landslide risk and this analysis does not account for all aspects of landslide hazard.

3.3.4 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk to landslide hazard:

- Nearly all of Linn County's exposure to landslide hazard occurs east of Brownsville and Lebanon.
- A very large number of buildings are exposed to Very High landslide hazard between Lebanon and Sweet Home due to steep slopes in the South Santiam River valley.

3.4 Channel Migration

Channel migration is a dynamic process by which a stream's location changes over time. This process includes channel bed and bank erosion, sediment deposition, and channel avulsion, a process in which the stream abruptly moves to a new location on the floodplain. Many factors influence channel movement, including the local geology, size, and quantity of sediment within the river, discharge of water, vegetation, channel shape, and slope. Human changes to the channel, such as the construction of dams and levees, also have a major impact on how a channel changes its course. In combination, these factors affect how a river's energy and erosive power is dispersed. Straight, steep streams have highly concentrated erosive power; by contrast, curving channels that flow across wide and flat floodplains allow a river to dissipate its energy and deposit sediment over a wider area (Rapp and Abbe, 2003).

The area in which a stream channel moves laterally over a given time is known as a channel migration zone (CMZ). In places where development has occurred within the CMZ, structures are at risk for severe damage to foundations and infrastructure through erosion and flooding. The CMZ typically extends beyond the limits of the regulatory floodplain, but little consideration is given to this potential hazard. This factor contributes greatly to the level of risk that exists for many developed areas along streams (Rapp and Abbe, 2003).

The frequency and severity of channel migration may change over time due to changes in climate and precipitation patterns, land use, and how we manage our waterways. This study represents our current understanding of channel migration hazards and risk, but we recognize that channel migration mapping and risk assessments will need to be updated with time and changing conditions.

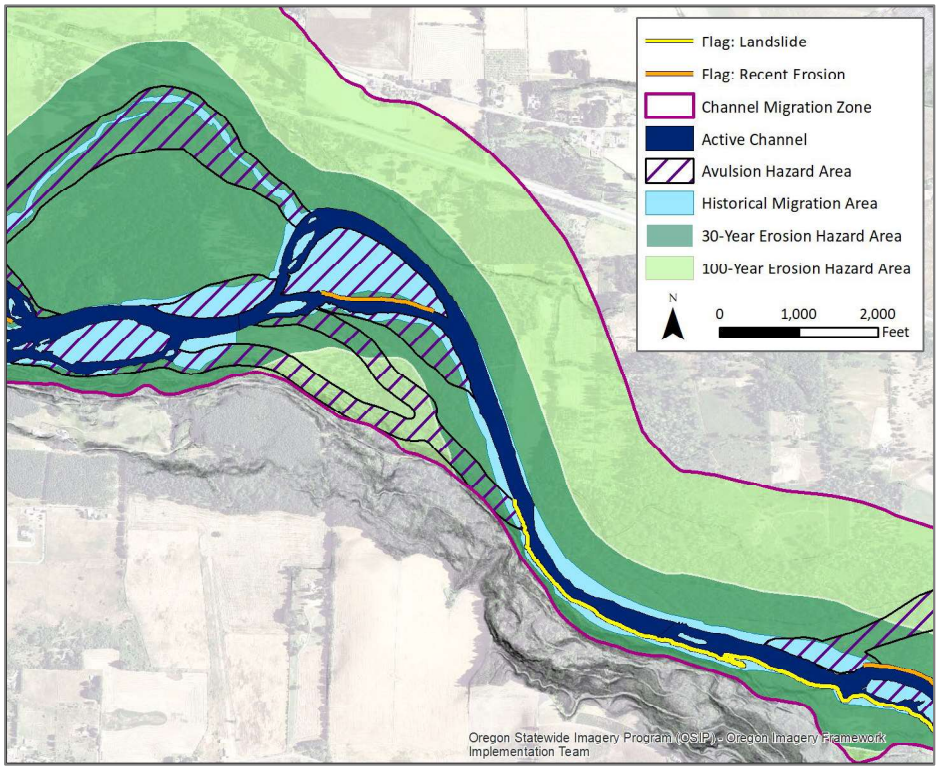
3.4.1 Data sources

The channel migration zones used for this report were developed by Appleby and others (2021) for the Santiam and North Santiam Rivers. DOGAMI's CMZ mapping considers areas of historical channel migration, potential erosion, and channel avulsion; these areas are mapped based on geology, historical aerial imagery, lidar topography, limited field work, and measured rates of historical channel migration. The methodology for developing the related zones and how they are combined are described in Appleby and others (2021). The CMZ is subdivided into seven subcomponents: the active channel, historical migration area, 30-year and 100-year erosion hazard areas, the avulsion hazard area, and flagged streambanks that are actively eroding or adjacent to landslides (**Figure 3-11**). The methodology for calculating each component and how they are combined are described in Appleby and others (2021).

It is important to note that this study only examines channel migration hazard along the Santiam and North Santiam Rivers due to data availability. There are other waterways in Linn County that could present additional channel migration hazard, including the Calapooia River. Structures built in proximity to these non-CMZ-mapped waterways are also potentially at risk to channel migration hazard.

To assess the exposure within each community, we overlaid buildings and critical facilities onto the CMZ. The following section presents the estimated total dollar value of exposed buildings and the number of people potentially displaced from the CMZ. Land value losses due to CMZ were not examined for this report.

Figure 3-11.Example diagram of the components of a CMZ map in Oregon, including the active channel (AC) in dark blue, historical migration area (HMA) in light blue, avulsion hazard area (AHA) with hatched lines, 30-year and 100-year erosion hazard areas (EHA) in dark and light green, flagged streambanks with yellow and orange lines, and channel migration zone (CMZ) boundary outlined in magenta (from Appleby and others, 2021).



3.4.2 Countywide results

Mapped channel migration areas along the Santiam and North Santiam rivers show a very high level of risk from this hazard for many communities along either watercourse. To quantify risk, the exposure analysis was conducted by determining which buildings were within or outside of the CMZ. Due to the frequency of shifting channel patterns in streams, channel migration can be a serious hazard in areas close to a stream regardless of hazard mapping or not.

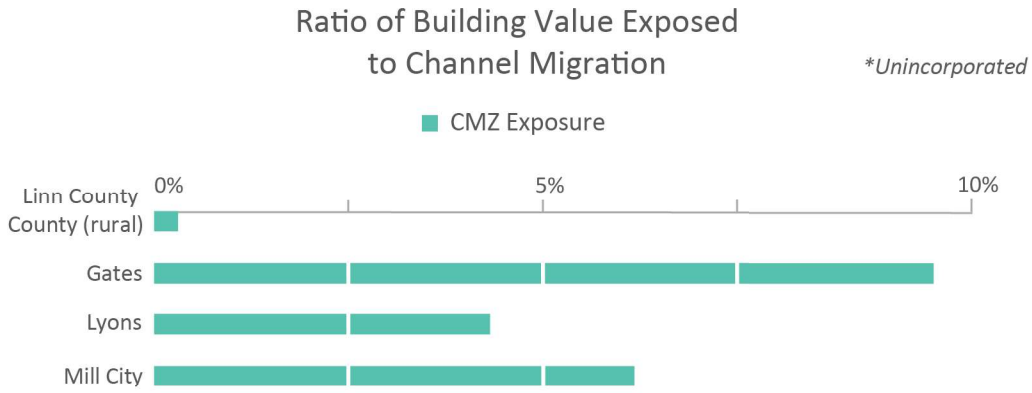
Linn County channel migration exposure (30-year erosion hazard area):

- Number of buildings: 420
- Value of exposed buildings: $109,629,000
- Percentage of total county value exposed: 0.4%
- Critical facilities exposed: 0 of 154
- Potentially displaced population: 508

A significant number of buildings in the unincorporated county and cities along the Santiam and North Santiam rivers are within areas where channel migration is likely to occur. Nearly 10% of the buildings in Gates are within the 30-year erosion hazard zone. **Figure 3-12** presents the estimated total building value

at risk from channel migration for the communities of Gates, Lyons, and Mill City. See **Appendix B: Detailed Risk Assessment Tables** for complete analysis results.

Figure 3-12. 30-year erosion hazard exposure by Linn County community within the study area of Appleby and others (2021).



Note: Communities in figure limited to communities within the study area of Appleby and others (2021).

3.4.3 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk to channel migration hazard:

- The North Santiam and Santiam rivers are highly susceptible to stream channel migration. Structures near and within these floodplains are at very high risk from channel migration hazard.

3.5 Volcanic Hazard – Lahar

A lahar is a water-saturated mixture of muddy debris and rock fragments that originates from a volcano and flows down channels at a rapid speed (exceeding 200 km/hr [120 mi/hr]). Lahars can occur on the flanks of a volcano with or without a volcanic eruption; non-eruption-related lahars can be initiated during heavy rains or by a sudden outburst of glacial melt where a volcano is covered with heavy loads of snow and ice. When this sudden large volume of water mixes with volcanic sediments and moves downslope, a damage-causing lahar can be produced.

Distal volcanic hazards, as opposed to proximal, are hazard types that affect outer areas away from the center of volcanic activity. A lahar is considered a distal volcanic hazard because they can travel large distances, causing damage to anything in their path. Because lahars have high drag and buoyancy forces resulting from the high sediment content of the flow, they have the capability to move large objects such as trees and vehicles and destroy infrastructure such as houses and bridges. They also can influence water quality, depending on the water sources used by affected communities.

For additional detailed information on volcanic hazards and potential impacts, the interested reader should review Walder and others (1999), "Volcano Hazards in the Mount Jefferson Region". This report discusses the risk from lahars to the Detroit Dam and Detroit Lake. If lahars entered this lake, they could cause large waves that could overtop the dam and possibly cause dam failure, with catastrophic effects downstream. Such events have very low probabilities but great potential consequences (Walder and others, 1999).

The eruptive history of Mount Jefferson is not well known. The last major eruption occurred somewhere between 35,000 and 100,000 years ago (Walder and others, 1999). Tephra that was sourced from this eruption has been found in southeast Idaho. Extensive pyroclastic flows during this same time period moved down the flanks of Mount Jefferson, along the Whitewater River on the east and Whitewater Creek on the west. Since data for this specific event was not available, exposure analysis to this eruption was not conducted.

3.5.1 Data sources

The lahar zones used in this report were created by Walder and others (1999) and were based on previous volcanic eruptions to estimate the extent of potential lahars on Mount Jefferson. Three nested lahar zones were computed based on an estimated volume of debris that could suddenly flow from Mount Jefferson. The largest and least likely scenario (>15,000-year annual recurrence) is designed at a volume of 500 million cubic meters (650 million cubic yards) and would correspond to volcanic activity or a low-probability landslide event involving large flank failures not caused by magmatic intrusion (Walder and others, 1999). The intermediate and small lahar scenarios are based on more likely events ranging from small eruptions, stream explosion, or rain-on-snow events. Such events are estimated to produce volumes of debris smaller than the largest scenario. The intermediate scenario, categorized in this report as "Medium," has an estimated volume of 100 million cubic meters (130 million cubic yards) with an annual recurrence of 1,000 to 15,000 years. The smallest scenario, categorized as "Small," has an estimated volume of 20 million cubic meters (25 million cubic yards) with an annual recurrence of 100 to 1,000 years.

For this risk assessment, we compared the locations of buildings and critical facilities to the geographic extent of the lahar inundation zones to assess the exposure for each community (**Appendix B: Table B**). The exposure results shown below are for only the Medium scenario.

The following section presents the estimated total dollar value of exposed buildings and the number of people potentially displaced from the Medium lahar hazard zone. Land value losses were not examined for this report. Refer to **Figure 3-13** to view the cumulative multi-scenario analysis results.

3.5.2 Countywide results

It is important to understand that volcanic hazards differ from earthquake or flood hazards on a timing basis. Earthquakes and floods tend to happen in relatively short windows, from minutes to hours, and recovery can usually begin within days or weeks after the event. By contrast, volcanic hazards can last days to decades, delaying a region's ability to recover. The aftermath of a volcanic event can lead to periods of localized channel transport of lahar material, precipitation patterns for the region can also lead to increased debris flows due to increased discharge in the riverine environment. Results of this study examine a single volcanic event, not the cumulative effects of all hazards from a volcanic eruption (Walder and others, 1999).

Most of the 132,000 residents in the study area are not exposed to lahar hazard, but the hazard poses significant concerns for those closer to Mount Jefferson and within riverine valleys. The total dollar value of exposed buildings was summed for the study area and is shown in **Figure 3-13**. The communities most threatened from a lahar event are Gates, Lyons, and Mill City.

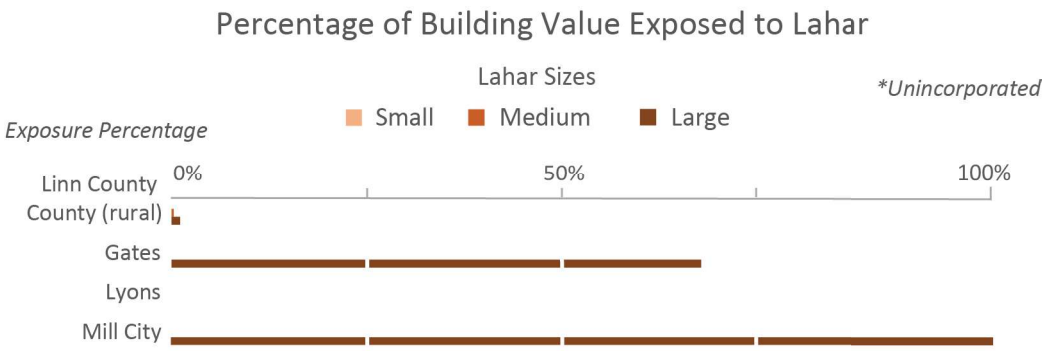
For this risk assessment, the results of the exposure analysis were limited to the communities included in the report by Walder and others (1999) that fall within the study area, which are those communities along the North Santiam River and the unincorporated county.

Linn County study area volcanic lahar exposure (Medium scenario):

- Number of buildings: 2,313
- Value of exposed buildings: $559,662,000
- Percentage of total county value exposed: 2.1%
- Critical facilities exposed: 6 of 154
- Potentially displaced population: 2,778

Lahar hazard is not a concern for the vast majority of residents in Linn County. However, developed areas along Route 22 (North Santiam Highway) on the western slope of Mount Jefferson have a high exposure to volcanic lahar hazard. Buildings that are located outside of the riverine valleys of Mount Jefferson are at much lower to zero risk from lahar hazard. The communities with the highest risk from a lahar event are Gates and Mill City.

Figure 3-13. Lahar risk exposure by Linn County community.



Note: Communities in figure are limited to communities within the study area of Burns and others (2011).

3.5.3 Areas of concern

- Lahar risk is confined to river valley channels and is a higher risk for communities and infrastructure closer to Mount Jefferson.
- Lahar risk is present for all buildings near the North Santiam River along state Highway 22.

3.6 Wildfire

Wildfires are a natural part of the ecosystem in Oregon. However, wildfires can present a substantial hazard to life and property in communities, especially those experiencing rapid growth. The most common wildfire conditions include hot, dry, and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, its behavior is influenced by numerous conditions, including fuel, topography, weather, drought, and development (Gilbertson-Day and others, 2018). Post-wildfire natural hazards can also present risk. These usually include flood, debris flows, and landslides. These post-wildfire hazards were not evaluated in this project.

The 2024 Linn County Community Wildfire Protection Plan (LCCWPP) recommended that the county develop policies addressing fire restriction enforcement, wildland urban interface standards, and building code enforcement related to emergency access. Forests cover large portions of the study area and play an important role in the local economy, but also surround homes and businesses (LCCWPP, 2024). Contact the Linn County Planning Department for specific requirements related to the county's comprehensive plan.

Linn County was impacted by the 2020 Labor Day Fires, specifically the Beachie Creek and Lionshead Wildfires. These fires are termed "megafires" because they were greater than 100,000 acres in size. The Beachie Creek wildfire burned nearly 194,000 acres and the Lionshead wildfire burned 205,000 acres (Northwest Interagency Coordination Center website, accessed 2/25/2022). The fires resulted in severe impacts to the built and natural environment in Linn and Marion counties and directly demonstrate the significant wildfire risk in Linn County. The Oregon Department of Emergency Management estimates that more than 1,500 structures, including 700 homes, were destroyed from these wildfires with an estimated $600 million in losses.

The frequency, intensity, and severity of wildfires may change over time due to changes in climate, drought conditions, urbanization, and how we manage our forested lands. This study represents our current understanding of wildfire hazards and wildfire risk, but we recognize that wildfire models and risk assessments will need to be updated with time and changing conditions.

3.6.1 Data sources

The Pacific Northwest Quantitative Wildfire Risk Assessment (PNRA): Methods and Results (Gilbertson-Day and others, 2018) is a comprehensive report that includes a database of spatial information related to wildfire hazard developed by the United States Forest Service (USFS) for the states of Oregon and Washington. The steward of this database in Oregon is the Oregon Department of Forestry (ODF). The database was created to assess the level of risk residents and structures have to wildfire. For this project, the burn probability dataset, a dataset included in the PNRA database, was used to measure the risk to communities in Linn County.

Using guidance from ODF, we categorized the Overall Wildfire Risk dataset into Low, Moderate, and High hazard zones for the wildfire exposure analysis. Overall Wildfire Risk was developed as a combination of burn probability and the presence of infrastructure and assets. The range of values in the dataset describe the level of potential impact and are characterized by negative values that indicate very high risk to zero, which indicates Low risk. The risk dataset also includes positive values that represent uninhabited areas that benefit from wildfire, but these were combined into the Low risk category (Gilbertson-Day and others, 2018).

Overall Wildfire Risk values were grouped into three hazard categories:

- Low wildfire hazard (-0.000011 to 0.005)
- Moderate wildfire hazard (-0.000119 to -0.000011)
- High wildfire hazard (-0.203 to -0.000119)

We overlaid the buildings layer and critical facilities on each of the wildfire hazard zones to determine exposure. In certain areas no wildfire data is present which indicates areas that have minimal risk to wildfire hazard (see **Appendix B: Table B-8**). The following section presents the estimated total dollar value of exposed buildings, and the number of people potentially displaced from wildfires. Land value losses as well as impacts on infrastructure and the natural environment were not examined for this report.

3.6.2 Countywide results

This study focuses on the High and Moderate hazard because they represent areas that have the highest potential for losses. Moderate wildfire risk is included with High risk in the assessment of exposure, because under certain conditions Moderate risk zones can be very susceptible to burn. In combining the High and Moderate risk categories within Linn County, we can emphasize areas where lives and property are most at risk.

Linn Countywide wildfire exposure (High or Moderate risk):

- Number of buildings: 3,871
- Value of exposed buildings: $811,012,000
- Percentage of total county value exposed: 3.1%
- Critical facilities exposed: 6 of 154
- Potentially displaced population: 4,419

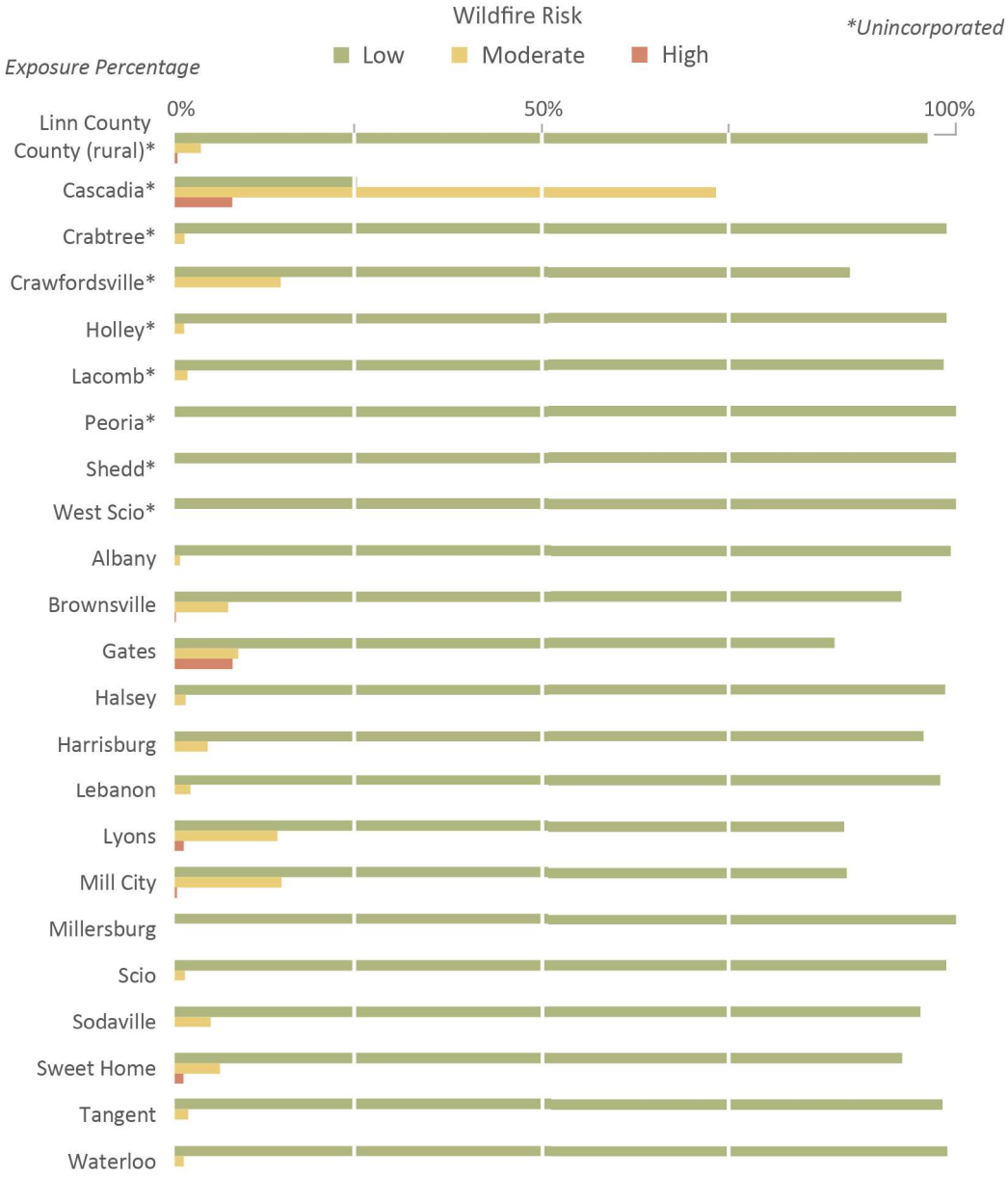
For this risk assessment, the building locations were compared to the geographic extent of the wildfire risk categories. More than 3,800 buildings in the heavily forested parts of central and eastern Linn County are exposed to High or Moderate wildfire hazard. Wildfires significantly impact the communities of Cascadia, Crawfordsville, Gates, Lyons, Mill City, and Sweet Home. **Figure 3-14** illustrates the level of risk from wildfire for the different communities of Linn County. See **Appendix B: Detailed Risk Assessment Tables** for multi-scenario analysis results.

3.6.3 Future conditions: wildfire hazard

Climate change has been recognized as a significant factor contributing to the increased frequency and severity of wildfires in various parts of the world. The effects of climate change on wildfire hazards are multifaceted and pose significant challenges to ecosystems, communities, and economies. Climate change increases the likelihood of wildfires through increased temperatures, drought conditions, reduced snowpack, altered precipitation patterns, and changes in vegetation (OCCRI, 2023).

The frequency, intensity, and size of wildfires are expected to continue to increase for the Pacific Northwest. The number of High fire danger days per year in Linn County are projected to increase an average of 12 days (range -6 to 31) by the 2050s, from the current average per year of 36.5. In addition, the number of days where vapor pressure deficit is extreme (another factor that impacts wildfire hazard) is expected to increase by 28 days (range 10 to 43) in the next 30 years from the current average per year of 24.5.

Figure 3-14. Wildfire risk exposure by Linn County community



3.6.4 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk to wildfire hazard:

- Portions of Linn County that are at greatest risk from wildfires are primarily along the North Santiam River, which includes the communities of Lyons, Gates, and Mill City (and Idanha). These communities were also severely affected by the 2020 wildfires.

- The entire heavily forested eastern half of Linn County (the Cascades) is at Moderate to High risk from wildfire. Very little development is present in these areas, with the exception of the community of Cascadia.

4.0 CONCLUSIONS

The purpose of this study is to provide a better understanding of the potential impacts from multiple natural hazards at the community scale. We accomplished this by using the latest natural hazards data and methods to quantify risk to buildings and people. This detailed approach provides new context for the county's risk reduction efforts. We note several important findings based on the results of this study:

- **Significant damage and losses for most areas in Linn County can occur from earthquake hazard**—Based on the results of the CSZ Mw 9.0 earthquake analysis, many communities in Linn County will experience building losses ranging from 10% to 17%. Generally, buildings in the western portion of Linn County will experience more damage from a CSZ Mw 9.0 earthquake than the eastern half. Based on the results of a Turner and Mill Creek Fault Mw 6.6 earthquake analysis, some communities in Linn County will experience at least some impact and disruption from such an event. Results show that this earthquake could cause building value losses of approximately 20% in Millersburg, Scio, Crawfordsville, and West Scio, primarily due to their proximity to the hypothetical earthquake epicenter. Buildings in the floodplains of the Santiam River, South Santiam River, Truax Creek, and Willamette River are at higher damage risk from either earthquake scenario due to significantly higher liquefaction susceptibility. Building age, proximity to a potential earthquake source, and liquefiable soils all contribute to the estimated levels of losses expected in Linn County.
- **Retrofitting buildings to modern seismic building codes can reduce damages and losses from earthquake shaking**—Our study shows that seismic building codes have a major influence on earthquake shaking damage. We found that retrofitting to at least Moderate code was the most efficient mitigation strategy because the additional benefit from retrofitting to High code was minimal. In our simulation of upgrading buildings to at least Moderate code, the estimated loss for the entire study area was reduced from 10% to 7% for a CSZ Mw 9.0 event and 9% to 7% for a Turner and Mill Creek Fault Mw 6.6. Communities with older buildings that were constructed below the Moderate-code standards are both the most vulnerable and have the greatest potential for risk reduction. For example, the community of Shedd could reduce losses from 17% to 10% for a CSZ Mw 9.0 event by retrofitting all buildings to at least Moderate code. While seismic retrofits are an effective strategy for reducing earthquake shaking damage, it should be noted that earthquake-induced liquefaction hazards will also be present in areas along some of the major streams in the county; these hazards require additional study and different geotechnical mitigation strategies.
- **Some communities in the study area are at moderate risk from flooding**—Many buildings within the floodplain are vulnerable to significant damage from flooding. At first glance, Hazus flood loss estimates may give a false impression of lower risk because they show lower damages within individual communities relative to other hazards we examined. This is likely due to the difference between the type of results from loss estimation and exposure analysis, as well as the limited area impacted by flooding. Flooding is one of the most frequently occurring natural hazards and thus, commonly has repetitive losses that occur with recurrence intervals of tens to hundreds of years, versus earthquake hazards, with recurrence intervals of hundreds to

thousands of years. We estimate that an average of 18% building value loss exists for buildings within the 100-year flood zone. The buildings most vulnerable to flood hazard within the study lie along the Willamette River, Mill Creek, Thomas Creek, South Santiam River, and North Santiam River.

- **Elevating structures in the flood zone reduces vulnerability**—We used an exposure analysis in addition to Hazus loss estimation to identify buildings that were not damaged but were within the area expected to experience a 100-year flood. By using both analyses in this way, the number of elevated structures within the flood zone could be quantified. This showed possible mitigation needs in flood loss prevention and the effectiveness of past activities. For example, in the City of Scio an estimated 50 buildings exposed to flooding are elevated above the base flood elevation (BFE). Based on the number of buildings exposed to flooding throughout the county, many would benefit from elevating above the level of flooding.
- **Landslide risk is significant for steeper areas in the county**—The recent landslide mapping used in this study was created using lidar and modern mapping methods to develop very accurate landslide hazard maps. We used an exposure analysis to assess the threat from landslide hazards. The developed areas in the central part of Linn County where Highway 20 intersects Route 228, in the vicinity of Brownsville, Sodaville, Crawfordsville, and Holley, are highly susceptible to landslide hazard s. Nearly 12% of the buildings in Brownsville and Sodaville are exposed to Very High or High landslide hazard.
- **Channel migration is a hazard for buildings in the riverine valleys of the study area**—Exposure analysis shows that channel migration hazard is a threat to communities and buildings along the North Santiam and Santiam rivers, specifically the community of Gates which has approximately 10% of its buildings exposed to the hazard. Buildings along the Willamette and Calapooia rivers were not evaluated for CMZ in this report.
- **Wildfire risk is higher in the WUI portions of the county**—Exposure analysis shows that buildings in rural central and eastern portions of the county are at higher risk from wildfire than other areas in the county. The communities of Cascadia, Crawfordsville, Gates, Lyons, Mill City, and Sweet Home have the highest risk from wildfire.
- **Most of the study area's critical facilities are at greatest risk from a CSZ Mw 9.0 earthquake hazard, relative to other hazards**—Because of their importance during and after a natural disaster, we identified and examined the risk to critical facilities for each hazard. We estimate that 23% (35 of 154) of Linn County's critical facilities will be nonfunctioning after a CSZ Mw 9.0 earthquake and 22% (34 of 154) will be nonfunctioning after a Turner and Mill Creek Fault Mw 6.6 earthquake. We also found that six critical facilities are exposed to wildfire hazard.
- **People are most likely to be displaced from their homes due to earthquake, wildfire, and landslide hazards**—We estimated that 4% of the permanent residents in the county could be displaced from a CSZ Mw 9.0 or a Turner and Mill Creek Fault Mw 6.6 earthquake. Permanent residents are vulnerable to displacement at a rate of 3.4% due to wildfire hazard and 4.6% due to landslide hazard. A small percentage of residents are vulnerable to displacement from flood, channel migration, and lahar hazards.
- **These results allow communities to compare risk across hazards and prioritize their needs**—The impact of multiple natural hazards was assessed for each community in Linn County. This allows for comparison of risk for a specific hazard between communities. It also allows for a comparison between different hazards, though care must be taken to distinguish loss estimates

and exposure results. The loss estimates and exposure analyses can assist in developing plans that address the concerns of those individual communities.

5.0 LIMITATIONS

There are several limitations to keep in mind when interpreting the results of this risk assessment.

- **Spatial and temporal variability of natural hazard occurrence** – With the exception of earthquakes, other hazards like flood, landslide, channel migration, and wildfire are extremely unlikely to occur across the fully mapped extent of the hazard zones. For example, areas mapped in the 100-year flood zone will be prone to flooding on occasion in certain watersheds during specific events, but not all at once throughout the entire county or even an entire community. While we report the overall impacts of a given hazard scenario, the losses from a single hazard event probably will not be as severe and widespread.
- **Loss estimation for individual buildings** – Hazus is a model, not reality, which is an important factor when considering the loss ratio of an individual building. On-the-ground mitigation, such as elevation of buildings to avoid flood loss, has been only minimally captured. Also, due to a lack of building material information, assumptions were made about the distribution of wood, steel, and un-reinforced masonry buildings. Loss estimation is most insightful when individual building results are aggregated to the community level because it reduces the impact of data outliers.
- **Loss estimation versus exposure** – We recommend careful interpretation of exposure results. This is due to the spatial and temporal variability of natural hazards (described above) and the inability to perform loss estimations due to the lack of Hazus damage functions. Exposure is reported in terms of total building value, which could imply a total loss of the buildings in a particular hazard zone, but this is not the case. Exposure is simply a calculation of the number of buildings and their value and does not make estimates about the level to which an individual building could be damaged.
- **Population variability** – Some of the communities in Linn County have vacation homes and rentals, which are more often occupied during the summer. Our estimates of potentially displaced people rely on permanent populations based on PSU Population Research Center data. As a result, we are slightly underestimating the number of people that may be in harm's way on a summer weekend.
- **Data accuracy and completeness** – Some datasets in our risk assessment had incomplete coverage or lacked high-resolution data within the study area. We used lower-resolution data where there was incomplete coverage or where high-resolution data was not available. We made assumptions to amend areas of incomplete data coverage based on reasonable methods described within this report. Data layers in which assumptions were made to fill gaps are building footprints, population, some building specific attributes, and landslide susceptibility. Many of the datasets included known or suspected artifacts, omissions, and errors, however repairing these issues were beyond the scope of the project and are areas needing additional research. We are aware that some uncertainty has been introduced from these data amendments at an individual building scale, but at community-wide scales the effects of the uncertainties are slight.
- **Changing Conditions** – This assessment did not account for potential changes in climate, land use, or population; it is a snapshot of Linn County's current risk from natural hazards. Human-induced climate change poses a significant and widespread risk to people around the world. In

Oregon, climate change is expected to impact the frequency and intensity of floods, wildfires, and landslides, but quantifying this impact was beyond the scope of this study.

6.0 RECOMMENDATIONS

The following actions are needed to better understand hazards and reduce risk to natural hazard through mitigation planning. These implementation areas, while not comprehensive, touch on all phases of risk management and focus on awareness and preparation, planning, emergency response, mitigation funding opportunities, and hazard-specific risk reduction activities.

6.1 Awareness and Preparation

Natural hazard awareness is crucial to lowering risk and lessening the impacts of natural hazards. When community members understand their risk and know the role that they play in preparedness, the community will become a much safer place to live. Awareness and preparation not only reduce the initial impact from natural hazards, but they also reduce the time a community needs to recover from a disaster, commonly referred to as "resilience."

This report is intended to provide local officials with a comprehensive and authoritative profile of natural hazard risk to underpin their public outreach efforts.

Messaging can be tailored to stakeholder groups. For example, outreach to homeowners could focus on actions they can take to reduce risk to their property. The DOGAMI Homeowners Guide to Landslides (https://www.oregongeology.org/Landslide/ger_homeowners_guide_landslides.pdf) provides a variety of risk reduction options for homeowners who live in high landslide susceptibility areas. This guide is one of many existing resources. Agencies partnering with local officials in the development of additional effective resources could help reach a broader community and user groups.

6.2 Planning

This report can help local decision-makers develop their local plans by identifying geohazards and associated risks to the community. The primary framework for accomplishing this is through the comprehensive planning process. The comprehensive plan sets the long-term trajectory of capital improvements, zoning, and urban growth boundary expansion, all of which are planning tools that can be used to reduce natural hazard risk.

Another framework is the natural hazard mitigation plan (NHMP) process. NHMP plans focus on characterizing natural hazard risk and identifying actions to reduce risk. Additionally, the information presented here can be a resource when updating the mitigation actions and inform the vulnerability assessment section of the NHMP plan.

While there are many similarities between this report and an NHMP, the primary difference is that the risk assessment is not a planning document. Additional differences can be the hazards or critical facilities examined in each report. Differences between the reports may be due to data availability or limited methodologies for specific hazards. The critical facilities considered in this report may not be identical to those listed in a typical NHMP due to the lack of damage functions in Hazus for non-building structures and to different considerations about emergency response during and after a disaster.

6.3 Emergency Response

Critical facilities will play a major role during and immediately after a natural disaster. This study can help emergency managers identify vulnerable critical facilities and develop contingency plans. Additionally, detailed mapping of potentially displaced residents can be used to re-evaluate evacuation routes and identify vulnerable populations to target for early warning.

The building database that accompanies this report presents many opportunities for future pre-disaster mitigation, emergency response, and community resilience improvements. Vulnerable areas can be identified and targeted for awareness campaigns. These campaigns can be aimed at pre-disaster mitigation through, for example, improvements of the structural connection of a building's frame to its foundation. Emergency response entities can benefit from the use of the building dataset through identification of potential hazards and populated buildings before and during a disaster. Both reduction of the magnitude of the disaster and a decrease in the response time contribute to a community's overall resilience.

6.4 Mitigation Funding Opportunities

Several state and federal funding options are available to communities that are susceptible to natural hazards and have specific cost-effective mitigation projects they wish to accomplish. The Oregon Office of Emergency Management (OEM) State Hazard Mitigation Officer (SHMO) can provide communities assistance in determining eligibility, finding mitigation grants, and navigating the mitigation grant application process. OEM has produced a document that can assist local officials in applying for mitigation funds (https://www.oregon.gov/OEM/Documents/Oregon_Hazard_Mitigation_Grant_Program_Handbook.pdf).

At the time of writing this report, FEMA has five programs that assist with mitigation funding for natural hazards: Hazard Mitigation Grant Program (HMGP), HMGP Post-Fire Assistance, Pre-Disaster Mitigation (PDM) Grant Program, Building Resilient Infrastructure and Communities (BRIC) grant program, and Flood Mitigation Assistance (FMA) (https://www.fema.gov/grants/mitigation). The SHMO can help with finding further opportunities for earthquake and tsunami assistance and funding.

6.5 Hazard-Specific Risk Reduction Actions

6.5.1 Earthquake

- Evaluate critical facilities for seismic preparedness by identifying structural deficiencies and vulnerabilities to dependent systems (e.g., water, fuel, power).
- Evaluate vulnerabilities of critical facilities. We estimate that 73% of critical facilities (**Appendix A: Community Risk Profiles**) will be damaged by a CSZ earthquake scenario described in this report, which will have many direct and indirect negative effects on first-response and recovery efforts.
- Identify communities and buildings that would benefit from seismic upgrades.

6.5.2 Flood

- Map areas of potential flood water storage areas.

- Identify structures that have repeatedly flooded in the past and would be eligible for FEMA's "buyout" program.
- Additional risk reduction strategies may be found on FEMA's website at https://www.ready.gov/floods.

6.5.3 Landslide

- Create modern landslide inventory and susceptibility maps.
- Monitor ground movement in high susceptibility areas.
- Evaluate risks to transportation networks and land value losses due to landslides in future risk assessments.
- Study the risk from landslides that are experience channel erosion at the toe of the landslide.
- Additional risk reduction strategies may be found on FEMA's website at https://www.ready.gov/landslides-debris-flow.

6.5.4 Channel migration

- Future development in areas with the largest CMZs, particularly North Santiam and Santiam rivers, could incorporate CMZ mitigation strategies into plans and designs.
- Evaluate the losses in land value or productivity due to channel migration.
- Evaluate risks to transportation networks and bridges due to channel migration.
- Identify areas suitable for conservation corridors along rivers that are at risk from channel migration. These can be multi-purpose including areas that provide or improve flood water storage, riparian and aquatic habitat restoration, climate change resilience, and water quality.

6.5.5 Volcanic hazard — lahar

- Awareness campaign focusing on the risk and evacuation protocols for areas with elevated exposure, conduct exercises to test protocols.
- Maintain appropriate setbacks in riverine valleys susceptible to lahar. The additional benefit would be a reduction of impacts from flooding and channel migration.

6.5.6 Wildfire-related geologic hazards

- Evaluate post-wildfire geologic hazards including flood, debris flows, and landslides.
- Additional risk reduction strategies may be found on FEMA's website at https://www.ready.gov/wildfires.

7.0 ACKNOWLEDGMENTS

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9.0 APPENDICES

Appendix A. Community Risk Profiles..... Error! Bookmark not defined.
Appendix B. Detailed Risk Assessment Tables 83
Appendix C. Vulnerability Assessment of Lifelines.....93
Appendix D. Hazus Methodology 98
Appendix E. Acronyms and Definitions.....104
Appendix F. Map Plates 106

APPENDIX A. COMMUNITY RISK PROFILES

This appendix contains community specific data to provide an overview and a better understanding about the relative levels of risk from each natural hazard analyzed for the purpose of fostering risk reduction efforts. Increasing disaster preparedness, public hazards communication, and education, ensuring functionality of emergency services, and ensuring access to evacuation routes are actions that every community can take to reduce their risk.

A.1 Unincorporated Linn County (Rural) 57
A.2 Unincorporated Community of Cascadia 59
A.3 Unincorporated Community of Crabtree 60
A.4 Unincorporated Community of Crawfordsville 61
A.5 Unincorporated Community of Holley 62
A.6 Unincorporated Community of Lacomb 63
A.7 Unincorporated Community of Peoria 64
A.8 Unincorporated Community of Shedd 65
A.9 Unincorporated Community of West Scio 65
A.10 City of Albany 67
A.11 City of Brownsville 69
A.12 City of Gates 70
A.13 City of Halsey 71
A.14 City of Harrisburg 72
A.16 City of Lebanon 73
A.17 City of Lyons 75
A.18 City of Mill City 76
A.19 City of Millersburg 77
A.20 City Scio 78
A.21 City of Sodaville 78
A.22 City of Sweet Home 80
A.23 City of Tangent 81
A.24 City of Waterloo 81

A.1 Unincorporated Linn County (Rural)

Table A-1. Unincorporated Linn County (rural) hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Unincorporated Linn County (rural)		35,839	45,792		26	12,020,435,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	1,275	3.6%	1,574	1	89,881,000	0.7%
Earthquake	CSZ Mw-9.0 Deterministic	894	2.5%	6,111	6	1,139,942,855	9.5%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	947	2.6%	5,305	4	988,024,312	8.2%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	5,287	15%	6,213	1	1,372,345,000	11%
Channel Migration	Channel Migration Zone	290	0.8%	324	0	79,728,000	0.7%
Wildfire	High and Moderate Risk	1,669	4.7%	2,251	0	439,756,000	3.3%
Volcanic Lahar	1% Annual Chance	789	2.2%	2,251	0	273,507,000	2.3%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

Table A-2. Unincorporated Linn County (rural) critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Volcanic Lahar - 1% Annual Chance
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Brownsville Rural Fire Dist - Station 61	-	-	-	-	-	-	-
Brownsville STP	-	-	-	-	-	-	-
Central Linn High School*	-	-	-	-	-	-	-
Clover Ridge Elementary School	-	X	X	-	-	-	-
East Linn Christian Academy	-	X	-	-	-	-	-
Electric Distribution	-	-	-	-	-	-	-
Halsey STP	-	-	-	-	-	-	-
Halsey-Shedd RFPD - Station 54	-	-	-	-	-	-	-
Hamilton Creek School	-	-	-	-	-	-	-
Harris Private School	-	X	-	-	-	-	-
Harrisburg Water Facilities	-	-	-	-	-	-	-
Lake Creek Mennonite School	-	X	-	-	-	-	-
Lebanon Fire District - Station 33	-	-	-	-	-	-	-
Lebanon Fire District Station 35	-	-	-	X	-	-	-
Lebanon Water Intake Facility	-	-	-	-	-	-	-
Little Promises Children's Program	-	-	-	-	-	-	-
Lourdes Public Charter School	-	-	-	-	-	-	-
Lyons RFPD - Station 570	-	-	-	-	-	-	-
Samaritan Lebanon Community Hospital	-	-	-	-	-	-	-
Scio STP	-	-	-	-	-	-	-
Scio Public Works shops	X	-	-	-	-	-	-
Scio RFPD - Station 93	-	-	-	-	-	-	-
Skyline Christian Academy	-	-	-	-	-	-	-
Sweet Home Charter School	-	-	-	-	-	-	-
Sweet Home Fire and Ambulance Cascadia Substation	-	-	-	-	-	-	-
Tangent STP	-	-	-	-	-	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.

A.2 Unincorporated Community of Cascadia

Table A-3. Unincorporated Community of Cascadia hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Cascadia		116	231		0	27,896,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	0	0.3%	9	0	575,960	2.1%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0%	0	0	97,390	0.3%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	15	13%	41	0	4,592,000	17%
Wildfire	High and Moderate Risk	92	79%	171	0	21,393,000	76%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

A.3 Unincorporated Community of Crabtree

Table A-4. Unincorporated Community of Crabtree hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Crabtree		339	459		1	97,309,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	21	6.1%	133	1	14,269,464	15%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	29	8.6%	147	1	18,234,476	19%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	7	2%	12	0	1,198,000	1%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-5. Unincorporated Community of Crabtree critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Scio RFPD – Station 92	-	X	X	-	-

A.4 Unincorporated Community of Crawfordsville

Table A-6. Unincorporated Community of Crawfordsville hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Crawfordsville		279	374		2	80,383,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	27	9.5%	30	0	394,000	0.5%
Earthquake	CSZ Mw-9.0 Deterministic	14	5.0%	103	0	11,322,373	14%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	6	2.0%	41	0	5,279,500	6.6%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	9	3.1%	19	0	5,706,000	7.1%
Wildfire	High and Moderate Risk	40	14%	67	1	10,906	14%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-7. Unincorporated Community of Crawfordsville critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Crawfordsville Elementary School	-	-	-	-	-
Sweet Home Fire and Ambulance	-	-	-	-	X

A.5 Unincorporated Community of Holley

Table A-8. Unincorporated Community of Holley hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Holley		260	380		1	79,188,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	1	0	3,000	0.0%
Earthquake	CSZ Mw-9.0 Deterministic	3	1.0%	23	0	3,280,394	4.1%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	1	0.4%	9	0	1,250,036	1.6%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	26	10%	32	0	6,498,000	8.2%
Wildfire	High and Moderate Risk	2	0.8%	8	0	955,000	1%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-9. Unincorporated Community of Holley critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Holley Elementary School	-	-	-	-	-

A.6 Unincorporated Community of Lacomb

Table A-10. Unincorporated Community of Lacomb hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Lacomb		403	535		2	126,968,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	0	0%	4	0	2,871,810	2.3%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0%	4	0	2,083,269	1.6%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	8	1.9%	7	0	1,157,000	0.9%
Wildfire	High and Moderate Risk	13	3.2%	10	0	2,039,000	2%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-11. Unincorporated Community of Lacomb critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Lacomb School	-	-	-	-	-
Lebanon Fire District - Station 32	-	-	-	-	-

A.7 Unincorporated Community of Peoria

Table A-12. Unincorporated Community of Peoria hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Peoria		97	136		1	25,591,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	1	0	4,000	0%
Earthquake	CSZ Mw-9.0 Deterministic	4	3.7%	28	1	2,524,238	9.9%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0.1%	2	0	347,664	1.4%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	1	0	29,000	0.1%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-13. Unincorporated Community of Peoria critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Halsey-Shedd RFPD - Station 53	-	X	-	-	-

A.8 Unincorporated Community of Shedd

Table A-14. Unincorporated Community of Shedd hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Shedd		208	248		1	107,103,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	38	18%	44	0	2,397,000	2.2%
Earthquake	CSZ Mw-9.0 Deterministic	5	2.3%	42	0	18,285,600	17%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0.1%	4	0	2,833,576	2.6%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-15. Unincorporated Community of Shedd critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Halsey-Shedd RFPD - Station 52	-	-	-	-	-

Table A-16. Unincorporated Community of West Scio hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
West Scio	105	198	0	52,104,000	

Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	9	8.7%	75	0	8,294,827	16%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	28	27%	95	0	14,667,365	28%

Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with “First floor height” above the level of flooding (base flood elevation).

A.9 City of Albany

Table A-17. City of Albany hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Albany		48,668	20,286		33	7,004,487,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	108	0.2%	58	0	2,611,000	0%
Earthquake	CSZ Mw-9.0 Deterministic	2,307	4.7%	3,399	16	761,814,128	11%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	2,446	5.0%	3,067	19	704,757,418	10%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	33	0.1%	17	0	3,518,000	0.1%
Wildfire	High and Moderate Risk	275	0.6%	73	1	46,900,000	1%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-18. City of Albany critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	CSZ 9.0 Earthquake Moderate to Complete Damage >50% Prob.	Turner and Mill Creek 6.6 Moderate to Complete Damage >50% Prob.	Landslide High and Very High Susceptibility Exposed	Wildfire High or Moderate Risk Exposed
Albany Christian School	-	-	-	-	-
Albany Fire Department Station 11	-	-	-	-	-
Albany Fire Department Station 12	-	-	-	-	-
Albany Fire Department Station 13	-	-	-	-	-
Albany Options School	-	-	-	-	-
Albany Police Department	-	-	-	-	-
Albany Public Works	-	-	X	-	-
Albany-Millersburg WRF	-	-	X	-	-
Calapooia Middle School	-	-	-	-	-
Central Elementary School	-	X	X	-	-
Circle of Friends Learning Center	-	-	-	-	-
First United Methodist Early Learning Center	-	-	-	-	-
Good Shepherd Lutheran School	-	X	X	-	-
Lafayette Elementary School	-	-	-	-	-
Liberty Elementary School	-	X	X	-	-
Linn County Courthouse	-	X	X	-	-
Linn County Fairgrounds	-	-	X	-	-
Linn County Road Department	-	X	X	-	-
Linn County Sheriff's Office / Linn County Jail	-	X	X	-	-
Memorial Middle School	-	-	-	-	-
Oak Elementary School	-	X	X	-	-
Periwinkle Elementary School	-	-	-	-	-
Samaritan Albany General Hospital	-	-	-	-	-
Samaritan Geary Street Urgent Care Clinic	-	-	-	-	-
South Albany High School	-	X	-	-	X
South Shore Elementary School	-	-	-	-	-
Standard Christian School	-	X	-	-	-
Sundborn Children's House Montessori	-	-	-	-	-
Sunrise Elementary School	-	-	-	-	-
Takena Elementary	-	-	-	-	-
Timber Ridge School	-	-	-	-	-
Waverly Elementary School	-	X	-	-	-
West Albany High School	-	-	-	-	-

A.10 City of Brownsville

Table A-19. City of Brownsville hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Brownsville		1,846	1,326		2	284,607,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	180	9.7%	119	1	2,042,000	0.7%
Earthquake	CSZ Mw-9.0 Deterministic	70	3.8%	230	0	26,402,644	9.3%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	33	1.8%	124	0	14,539,754	5.1%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	237	13%	137	0	36,203,000	13%
Wildfire	High and Moderate Risk	162	8.8%	70	0	19,850,000	7.1%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-20. City of Brownsville critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Brownsville Public Works	X	-	-	-	-
Linn County Sheriff's Office and Brownsville Rural Fire District – Station 62	-	-	-	-	-

A.11 City of Gates

Table A-21. City of Gates hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Gates		493	326		3	70,923,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	3	0.5%	6	0	756,492	1.1%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0%	4	0	2,366,249	3.3%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	33	6.6%	27	0	6,929,000	9.8%
Wildfire	High and Moderate Risk	56	11%	46	0	11,012,000	15%
Volcanic Lahar	1% Annual Chance	323	65%	216	1	49,139,000	69%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-22. City of Gates critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Volcanic Lahar - 1% Annual Chance
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Gates City Hall	-	-	-	-	-	-	-
Gates Public Works Shop	-	-	-	-	-	-	X
Gates RFPD	-	-	-	-	-	-	-

A.12 City of Halsey

Table A-23. City of Halsey hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Halsey		955	602		5	182,922,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	26	2.7%	79	1	19,448,832	11%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0%	2	0	1,553,929	0.8%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	21	2.2%	15	0	2,534,000	1.4%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-24. City of Halsey critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Central Linn Elementary School*	-	-	-	-	-
Halsey City Hall and Community Center	-	X	-	-	-
Halsey Public Library	-	-	-	-	-
Halsey Public Works	-	-	-	-	-
Halsey-Shedd RFPD - Station 51*	-	-	-	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.

A.13 City of Harrisburg

Table A-25. City of Harrisburg hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Harrisburg		3,660	1,924		5	544,762,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	162	4.4%	403	0	65,086,627	12%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	1	0%	5	0	2,878,941	0.5%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	228	6.2%	76	0	22,789,000	4.2%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-26. City of Harrisburg critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Harrisburg City Hall	-	-	-	-	-
Harrisburg Fire and Rescue - Station 41	-	-	-	-	-
Harrisburg High School*	-	-	-	-	-
Harrisburg Middle School/Elementary School*	-	-	-	-	-
Linn County Sheriff's Office – Harrisburg Substation	-	-	-	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.

A.15 City of Lebanon

Table A-27. City of Lebanon hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Lebanon		20,320	8,789		29	2,688,032,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake	CSZ Mw-9.0 Deterministic	1,425	7.0%	2,092	3	333,797,893	12%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	1,422	7.0%	1,895	6	360,458,752	13%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	6	0%	7	0	826,000	0%
Wildfire	High and Moderate Risk	523	2.6%	153	1	54,052,000	2.0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-28. City of Lebanon critical facilities.

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Cascades School	-	X	X	-	-
Green Acres School	-	-	-	-	-
LBCC Advanced Transportation Technology Center	-	-	X	-	-
LBCC Lebanon Center	-	-	-	-	-
Lebanon City Hall	-	-	-	-	-
Lebanon City Storage	-	-	-	-	-
Lebanon Fire District - Station 31	-	-	-	-	-
Lebanon Fire District Station 34	-	-	-	-	-
Lebanon High School*	-	-	-	-	-
Lebanon Maintenance Training Bay	-	-	-	-	-
Lebanon Police Department	-	-	-	-	-
Lebanon State Airport	-	-	-	-	-
Lebanon Waterwater Treatment	-	-	X	-	-
Linn County Sheriff's Office – Lebanon Substation	-	-	-	-	-
Montessa Pump Station	-	-	-	-	-
Oregon Army National Guard	-	-	-	-	-
Park Drive Pump Station	-	-	-	-	-
Pioneer School	-	-	-	-	-
Riverview Elementary School	-	-	-	-	X
Samaritan Lebanon Community Hospital - East Linn Health Clinic	-	-	-	-	-
Samaritan Lebanon Community Hospital	-	-	-	-	-
Sand Ridge Charter – South Main Campus	-	-	-	-	-
Seven Oak Middle School	-	-	-	-	-
Water Treatment Plant	-	-	-	-	-
Western University COMP Northwest	-	-	X	-	-
Western University Health Sciences University	-	X	X	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.

A.16 City of Lyons

Table A-29. City of Lyons hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Lyons		1,203	1,074		5	223,889,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	11	0.9%	6	0	70,000	0%
Earthquake	CSZ Mw-9.0 Deterministic	23	1.9%	126	1	12,905,823	5.8%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	20	1.7%	75	1	9,900,919	4.4%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	8	0.6%	6	0	1,185,000	0.5%
Channel Migration	Channel Migration Zone	22	4.7%	22	0	8,509,000	3.8%
Wildfire	High and Moderate Risk	188	16%	194	0	31,971,000	14%
Volcanic Lahar	1% Annual Chance	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-30. City of Lyons critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Volcanic Lahar - 1% Annual Chance
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed	Exposed
City of Lyons Shop	-	-	-	-	-	-	-
Lyons City Hall	-	-	-	-	-	-	-
Lyons RFPD - Station 550	-	-	-	-	-	-	-
Lyons-Mehama Water District Shop	-	-	-	-	-	-	-
Mari-Linn Elementary School	-	X	-	-	-	-	-

A.17 City of Mill City

Table A-31. City of Mill City hazard profile.

Community Overview							
Community Name		Population	Number of Buildings	Critical Facilities[1]		Total Building Value ($)	
Mill City		1,671	1,060	4		237,466,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	CSZ Mw-9.0 Deterministic	5	0.3%	34	1	5,647,141	2.4%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	1	0.1%	5	0	1,770,598	0.7%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	21	1.2%	25	0	3,349,000	1.4%
Channel Migration	Channel Migration Zone	128	7.7%	47	0	14,463,000	6.1%
Wildfire	High and Moderate Risk	252	15%	153	2	33,177,000	14%
Volcanic Lahar	1% Annual Chance	1,667	99%	1059	4	237,016,000	99%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-32. City of Mill City critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Volcanic Lahar - 1% Annual Chance
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Linn County Sheriff's Office – Mill City Substation	-	-	-	-	-	-	X
Mill City Fire Department	-	-	-	-	-	X	X
Mill City Middle School	-	X	-	-	-	X	X
Santiam High School	-	-	-	-	-	-	X

A.18 City of Millersburg

Table A-33. City of Millersburg hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Millersburg		3,207	2,049		3	878,299,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	9	0.3%	5	0	61,000	0%
Earthquake*	CSZ Mw-9.0 Deterministic	65	2.0%	279	2	83,644,164	9.5%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	143	4.4%	447	2	158,515,773	18%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	1	0%	3	0	291,000	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-34. City of Millersburg critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Albany Fire Department - Millersburg Station 15	-	-	-	-	-
Jefferson RFPD - Millersburg	-	X	X	-	-
Millersburg City Hall	-	X	X	-	-

A.19 City Scio

Table A-35. City of Scio hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Scio		949	601		5	156,690,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	210	22%	87	1	914,000	0.6%
Earthquake*	CSZ Mw-9.0 Deterministic	73	7.7%	196	0	25,128,291	16%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	163	17%	243	2	39,965,839	26%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	4	0.4%	1	0	529,000	0.3%
Wildfire	High and Moderate Risk	11	1.2%	7	0	1,996,000	1.3%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-36. City of Scio critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Centennial Elementary School	-	-	X	-	-
Scio City Hall Library and Senior Center	-	-	-	-	-
Scio High School*	X	-	-	-	-
Scio Middle School*	-	-	-	-	-
Scio RFPD - Main Station	-	-	X	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.

A.20 City of Sodaville

Table A-37. City of Sodaville hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Sodaville		357	271		4	48,953,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	CSZ Mw-9.0 Deterministic	1	0.2%	12	0	1,421,274	2.9%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	1	0.2%	5	0	560,484	1.1%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	49	14%	34	0	5,831,000	12%
Wildfire	High and Moderate Risk	13	3.6%	15	0	2,238,000	4.6%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-38. City of Sodaville critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Sand Ridge Charter School – Sodaville Campus	-	-	-	-	-
Sodaville City Hall	-	-	-	-	-
Sodaville General Store	-	-	-	X	-
Sodaville water system building	-	-	-	-	-

A.21 City of Sweet Home

Table A-39. City of Sweet Home hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Sweet Home		10,028	6,313		10	1,466,569,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	55	0.5%	39	0	796,000	0.1%
Earthquake*	CSZ Mw-9.0 Deterministic	64	0.6%	334	0	42,142,096	2.9%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	14	0.1%	53	0	12,507,581	0.9%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	276	2.7%	170	0	33,736,000	2.3%
Wildfire	High and Moderate Risk	833	8.3%	516	1	100,826,000	6.9%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-40. City of Sweet Home critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Foster Elementary School	-	-	-	-	-	-	-
Hawthorne Elementary School	-	-	-	-	-	-	-
Oak Heights Elementary School	-	-	-	-	-	-	-
Sweet Home Fire and Ambulance No.21	-	-	-	-	-	-	-
Sweet Home Fire and Ambulance Station 22	-	-	-	-	-	-	-
Sweet Home High School	-	-	-	-	-	-	-
Sweet Home Junior High School	-	-	-	-	-	X	-
Sweet Home Police Department	-	-	-	-	-	-	-
City of Sweet Home	-	-	-	-	-	-	-
Willamette National Forest – Sweet Home Ranger District	-	-	-	-	-	-	-

A.22 City of Tangent

Table A-41. City of Tangent hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Tangent		1,218	1,064		4	407,086,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	4	0.3%	9	0	113,000	0%
Earthquake*	CSZ Mw-9.0 Deterministic	78	6.4%	316	1	53,119,121	13%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	19	1.5%	102	0	21,919,532	5.4%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	31	2.5%	32	0	7,049,000	1.7%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-42. City of Tangent critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Central Valley Christian School	-	-	-	-	-
Tangent City Hall	-	-	-	-	-
Tangent Elementary School	-	X	-	-	-
Tangent RFPD*	-	-	-	-	-

*Seismic upgrades have occurred for some or all of the buildings associated with this critical facility.

A.23 City of Waterloo

Table A-43. City of Waterloo hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Waterloo		216	203		1	32,851,000	
Hazus Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	CSZ Mw-9.0 Deterministic	13	5.8%	63	0	4,867,488	15%
Earthquake*	Turner and Mill Creek Fault Mw-6.6 Deterministic	11	5.3%	50	1	4,291,330	13%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	2	0.9%	2	0	7,049,000	1.1%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table A-44. City of Waterloo critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Waterloo City Hall	-	-	-	-	-

APPENDIX B. DETAILED RISK ASSESSMENT TABLES

Table B-1. Linn County building inventory 84
Table B-2. CSZ Mw-9.0 Earthquake loss estimates 85
Table B-3. Turner and Mill Creek Fault Mw-6.6 Earthquake loss estimates 86
Table B-4. Flood loss estimates 87
Table B-5. Flood exposure 88
Table B-6. Landslide exposure 89
Table B-7. Channel migration exposure 90
Table B-8. Wildfire exposure 91

Table B-1. Linn County building inventory.

(all dollar amounts in thousands)

	Residential			Commercial and Industrial			Agricultural			Public and Non-Profit			All Buildings			
Community	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Building Value ($)	Building Value per Community Total	Number of Buildings	Number of Buildings per Study Area Total	Building Value ($)	Value of Buildings per Study Area Total
Unincorp. Linn Co	21,754	6,284,412	52%	937	795,203	6.6%	22,986	4,815,610	40%	115	125,210	1.0%	45,792	49%	12,020,435	45%
Cascadia	104	19,843	71%	0	0	0%	127	8,053	29%	0	0	0%	231	0.2%	27,896	0.1%
Crabtree	214	58,629	60%	6	2,580	2.7%	237	34,153	35%	2	1,948	2.0%	459	0.5%	97,309	0.4%
Crawfordsville	199	48,077	60%	5	1,139	1.4%	164	24,990	31%	6	6,177	7.7%	374	0.4%	80,383	0.3%
Holley	181	45,801	58%	3	748	1%	188	25,814	33%	8	6,826	8.6%	380	0.4%	79,188	0.3%
Lacomb	263	66,472	52%	8	9,064	7.1%	264	51,433	41%	0	0	0.0%	535	1%	126,968	0%
Peoria	75	17,211	67%	0	0	0%	59	7,581	30%	2	800	3%	136	0.1%	25,591	0.1%
Shedd	109	38,163	36%	24	24,925	23%	104	33,869	32%	11	10,147	9%	248	0.3%	107,103	0.4%
West Scio	91	15,174	29%	31	27,991	54%	76	8,939	17%	0	0	0%	198	0.2%	52,104	0.2%
Total Unincorp. County	22,990	6,593,782	52%	1,012	861,494	7%	24,205	5,010,441	40%	144	151,107	1%	48,351	51%	12,616,823	47%
Albany	14,930	4,636,894	66%	1,241	1,737,236	25%	3,917	232,468	3%	198	397,888	5.7%	20,286	22%	7,004,487	26%
Brownsville	746	193,845	68%	53	29,851	10%	504	40,770	14%	23	20,141	7%	1,326	1%	284,607	1%
Gates	200	46,518	66%	6	3,639	5%	116	18,222	26%	4	2,544	3.6%	326	0%	70,923	0%
Halsey	358	102,732	56%	29	34,096	19%	197	16,785	9%	18	29,310	16%	602	1%	182,922	1%
Harrisburg	1,323	344,311	63%	129	126,567	23%	436	26,628	5%	36	47,256	9%	1,924	2%	544,762	2%
Lebanon	5,888	1,638,905	61%	474	710,451	4%	2,321	130,414	5%	106	208,262	8%	8,789	9%	2,688,032	10%
Lyons	597	156,943	70%	54	27,487	12%	413	33,622	15%	10	5,837	3%	1,074	1%	223,889	1%
Mill City	619	173,300	73%	20	7,952	3%	404	25,460	11%	17	30,754	13%	1,060	1%	237,466	1%
Millersburg	1,286	429,295	49%	333	361,323	41%	425	82,468	9%	5	5,213	1%	2,049	2%	878,299	3%
Scio	383	107,495	69%	26	16,197	10%	182	20,337	13%	10	12,661	8%	601	1%	156,690	1%
Sodaville	192	34,236	70%	1	59	0%	70	6,451	13%	8	8,207	17%	271	0%	48,953	0%
Sweet Home	3,897	955,074	65%	334	215,248	15%	1,982	154,626	11%	100	141,621	10%	6,313	7%	1,466,569	5%
Tangent	597	126,291	31%	155	210,726	52%	299	55,031	14%	13	15,037	4%	1,064	1%	407,086	2%
Waterloo	117	24,954	76%	1	306	1%	82	6,365	19%	3	1,225	4%	203	0%	32,851	0%
Total	54,123	15,564,575	58%	3,870	4,342,787	16%	35,553	5,860,089	22%	695	1,077,063	4%	94,241	100%	26,844,514	100%

Table B-2. CSZ Mw-9.0 Earthquake loss estimates.

(all dollar amounts in thousands)

			Total Earthquake Damage							
			Buildings Damaged				All Buildings Changed to At Least Moderate Code			
	Total Number of Buildings	Total Estimated Building Value ($)	Yellow-Tagged Buildings	Red-Tagged Buildings	Sum of Economic Loss	Loss Ratio	Yellow-Tagged Buildings	Red-Tagged Buildings	Sum of Economic Loss	Loss Ratio
Unincorp. Linn Co	45,792	12,020,435	4942	1169	1139943	9.5%	3535	818	844982	7.0%
Cascadia	231	27,896	9	1	576	2.1%	1	0	242	0.9%
Crabtree	459	97,309	107	26	14269	15%	90	22	12665	13%
Crawfordsville	374	80,383	84	19	11322	14%	61	15	8841	11%
Holley	380	79,188	19	4	3280	4.1%	16	4	2617	3.3%
Lacomb	535	126,968	4	0	2872	2.3%	0	0	1216	1.0%
Peoria	136	25,591	21	7	2524	9.9%	13	2	1646	6.4%
Shedd	248	107,103	34	9	18286	17%	22	4	10587	9.9%
West Scio	198	52,104	61	15	8295	16%	40	10	6962	13%
Total Unincorp. County	48,351	12,616,823	5280	1249	1201367	9.5%	3778	875	889757	7.1%
Albany	20,286	7,004,487	2770	629	761814	11%	1707	361	523660	7.5%
Brownsville	1,326	284,607	185	45	26403	9.3%	128	31	19658	6.9%
Gates	326	70,923	0	0	90	0.1%	0	0	76	0.1%
Halsey	602	182,922	65	14	19449	11%	46	10	15402	8.4%
Harrisburg	1,924	544,762	331	72	65087	12%	193	38	45143	8.3%
Lebanon	8,789	2,688,032	1703	389	333389	12%	1364	326	295221	11%
Lyons	1,074	223,889	111	16	12906	5.8%	45	9	8854	4.0%
Mill City	1,060	237,466	32	2	5647	2.4%	5	0	2583	1.1%
Millersburg	2,049	878,299	225	54	83644	9.5%	169	40	72963	8.3%
Scio	601	156,690	158	38	25128	16%	120	30	20757	13%
Sodaville	271	48,953	12	0	1421	2.9%	2	0	692	1.4%
Sweet Home	6,313	1,466,569	302	31	42142	3%	98	18	26290	2%
Tangent	1,064	407,086	256	60	53119	13%	122	18	38906	10%
Waterloo	203	32,851	52	11	4867	15%	39	10	4230	13%
Total	94,241	26,844,514	11483	2611	2636474	10%	7816	1765	1964193	7%

Table B-3. Turner and Mill Creek Fault Mw-6.6 Earthquake loss estimates.

(all dollar amounts in thousands)

			Total Earthquake Damage							
			Buildings Damaged				All Buildings Changed to At Least Moderate Code			
	Total Number of Buildings	Total Estimated Building Value ($)	Yellow-Tagged Buildings	Red-Tagged Buildings	Sum of Economic Loss	Loss Ratio	Yellow-Tagged Buildings	Red-Tagged Buildings	Sum of Economic Loss	Loss Ratio
Unincorp. Linn Co (rural)	45,792	12,020,435	4,062	1243	988,024	8.2%	3,519	888	816,282	6.8%
Cascadia	231	27,896	0	0	97	0.3%	0	0	48	0.2%
Crabtree	459	97,309	112	35	18,234	19%	105	26	16,036	17%
Crawfordsville	374	80,383	33	7	5,280	6.6%	27	7	4,328	5.4%
Holley	380	79,188	7	2	1,250	1.6%	6	1	1,049	1.3%
Lacomb	535	126,968	4	0	2,083	1.6%	2	0	1,198	0.9%
Peoria	136	25,591	2	0	348	1.4%	0	0	166	0.6%
Shedd	248	107,103	4	0	2,834	2.6%	1	0	1,445	1.3%
West Scio	198	52,104	56	39	14,667	28%	60	20	12,317	24%
Total Unincorp. County	48,351	12,616,823	4280	1,327	1,032,817	8.2%	3,721	942	852,869	6.8%
Albany	20,286	7,004,487	2316	751	704,757	10%	1,809	446	527,340	7.5%
Brownsville	1,326	284,607	100	24	14,540	5.1%	85	20	12,659	4.4%
Gates	326	70,923	4	0	2,366	3.3%	0	0	25	0.0%
Halsey	602	182,922	2	0	1,554	0.8%	1	0	1,071	0.6%
Harrisburg	1,924	544,762	5	0	2,879	0.5%	2	0	1,625	0.3%
Lebanon	8,789	2,688,032	1514	381	360,459	13%	1,367	334	321,375	12%
Lyons	1,074	223,889	61	14	9,901	4.4%	42	9	7,848	3.5%
Mill City	1,060	237,466	4	0	1,771	0.7%	1	0	895	0.4%
Millersburg	2,049	878,299	312	135	158,516	18%	301	86	141,041	16%
Scio	601	156,690	161	82	39,966	26%	155	45	31,226	20%
Sodaville	271	48,953	4	1	560	1.1%	2	0	309	0.6%
Sweet Home	6,313	1,466,569	46	7	12,508	1%	30	6	8,511	1%
Tangent	1,064	407,086	86	16	21,920	5%	45	7	16,634	4%
Waterloo	203	32,851	40	10	4,291	13%	34	8	3,815	12%
Total Study Area	94,241	26,844,514	8,937	2,748	2,368,805	9%	7,595	1,904	1,927,244	7%

Table B-4. Flood loss estimates.

			(all dollar amounts in thousands)											
			10% (10-yr)			2% (50-yr)			1% (100-yr)			0.2% (500-yr)		
Community	Total Number of Buildings	Total Estimated Building Value ($)	Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio
Unincorp. Linn Co	45,792	12,020,435	520	42,212	0.4%	1,243	70,483	0.6%	1,574	89,881	0.7%	3,566	216,505	1.8%
Cascadia	231	27,896	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Crabtree	459	97,309	0	0	0%	0	0	0%	0	0	0%	23	366	0.4%
Crawfordsville	374	80,383	2	42	0.1%	14	170	0.2%	30	394	0.5%	40	1,144	1.4%
Holley	380	79,188	0	0	0%	0	0	0%	1	3	0%	2	14	0%
Lacomb	535	126,968	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Peoria	136	25,591	1	0	0%	1	3	0%	1	4	0%	1	7	0%
Shedd	248	107,103	44	2,115	2.0%	44	2,647	2.5%	44	2,397	2.2%	47	3,346	3.1%
West Scio	198	52,104	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Total Unincorp. County	48,351	12,616,823	567	44,370	0.4%	1,302	73,303	0.6%	1,650	92,679	0.7%	3,679	221,383	1.8%
Albany	20,286	7,004,487	32	945	0%	48	1,912	0.%	58	2,611	0.04%	121	7,647	0.1%
Brownsville	1,326	284,607	60	709	0.2%	96	1,204	0.4%	119	2,042	0.7%	574	15,907	5.6%
Gates	326	70,923	0	0	0%	0	0	0%	0	0	0%	1	35	0%
Halsey	602	182,922	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Harrisburg	1,924	544,762	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Lebanon	8,789	2,688,032	0	0	0%	0	0	0%	0	0	0%	19	1,699	0.1%
Lyons	1,074	223,889	0	0	0%	3	8	0%	6	70	0%	24	959	0.4%
Mill City	1,060	237,466	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Millersburg	2,049	878,299	1	11	0%	2	37	0%	5	61	0%	24	390	0%
Scio	601	156,690	22	60	0%	62	468	0.3%	87	914	0.6%	151	1,749	1.1%
Sodaville	271	48,953	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Sweet Home	6,313	1,466,569	14	211	0%	27	513	0%	39	796	0.1%	63	1,435	0.1%
Tangent	1,064	407,086	2	69	0%	5	96	0%	9	113	0%	14	180	0%
Waterloo	203	32,851	0	0	0%	0	0	0%	0	0	0%	0	0	0%
Total	94,241	26,844,514	698	46,374	0.2%	1,545	77,541	0.3%	1,973	99,287	0.4%	4,670	251,384	0.9%

Table B-5. Flood exposure.

			1% (100-yr)				
Community	Total Number of Buildings	Total Population	Potentially Displaced Residents from Flood Exposure	% Potentially Displaced Residents from flood Exposure	Number of Flood Exposed Buildings	% of Flood Exposed Buildings	Number of Flood Exposed Buildings Without Damage
Unincorp. Linn Co	45,792	35,839	1,275	3.6%	1,735	3.8%	161
Cascadia	231	116	0	0%	0	0%	0
Crabtree	459	339	0	0%	0	0%	0
Crawfordsville	374	279	27	9.5%	35	9.4%	5
Holley	380	260	0	0%	1	0.3%	0
Lacomb	535	403	0	0%	0	0%	0
Peoria	136	97	0	0%	1	0.7%	0
Shedd	248	208	38	18%	44	18%	0
West Scio	198	105	0	0%	0	0%	0
Total Unincorp. County	48,351	37,644	1,340	3.6%	1,816	3.8%	166
Albany	20,286	48,668	108	0.2%	62	0.3%	4
Brownsville	1,326	1,846	180	9.7%	156	12%	37
Gates	326	493	0	0%	0	0%	0
Halsey	602	955	0	0%	0	0%	0
Harrisburg	1,924	3,660	0	0%	0	0%	0
Lebanon	8,789	20,320	0	0%	0	0%	0
Lyons	1,074	1,203	11	0.9%	8	0.7%	2
Mill City	1,060	1,671	0	0%	0	0%	0
Millersburg	2,049	3,207	9	0.3%	8	0.4%	3
Scio	601	949	210	22%	137	23%	50
Sodaville	271	357	0	0%	0	0%	0
Sweet Home	6,313	10,028	55	1%	46	1%	7
Tangent	1,064	1,218	4	0%	13	1%	4
Waterloo	203	216	0	0%	0	0%	0
Total	94,241	132,435	1,917	1%	2,246	2%	273

Table B-6. Landslide exposure.

(all dollar amounts in thousands)

Community	Total Number of Buildings	Total Estimated Building Value ($)	Very High Susceptibility			High Susceptibility			Moderate Susceptibility		
			Number of Buildings	Building Value ($)	Percent of Building Value Exposed	Number of Buildings	Building Value ($)	Percent of Building Value Exposed	Number of Buildings	Building Value ($)	Percent of Building Value Exposed
Unincorp. Linn Co	45,792	12,020,435	3,096	671,204	5.6%	3,117	701,140	5.8%	7,806	1,624,967	14%
Cascadia	231	27,896	8	1,008	3.6%	33	3,584	13%	61	7,877	28%
Crabtree	459	97,309	0	0	0%	0	0	0%	7	1,243	1%
Crawfordsville	374	80,383	3	3,088	3.8%	16	2,618	3.3%	26	4,359	5%
Holley	380	79,188	11	2,104	2.7%	21	4,394	5.5%	109	19,787	25%
Lacomb	535	126,968	0	0	0%	7	1,157	0.9%	88	17,180	14%
Peoria	136	25,591	0	0	0%	1	29	0.1%	0	0	0%
Shedd	248	107,103	0	0	0%	0	0	0%	0	0	0%
West Scio	198	52,104	0	0	0%	0	0	0%	4	332	1%
Total Unincorp. County	48,351	12,616,823	3,118	677,404	5%	3,193	712,768	5.6%	8,101	1,675,746	13%
Albany	20,286	7,004,487	0	0	0%	17	3,518	0.1%	1,894	556,987	8%
Brownsville	1,326	284,607	0	0	0%	137	36,203	13%	176	35,725	13%
Gates	326	70,923	0	0	0%	0	0	0%	5	1,070	2%
Halsey	602	182,922	0	0	0%	0	0	0%	4	865	0.5%
Harrisburg	1,924	544,762	0	0	0%	0	0	0%	26	7,797	1.4%
Lebanon	8,789	2,688,032	0	0	0%	7	826	0%	231	57,292	2.1%
Lyons	1,074	223,889	0	0	0%	6	1,185	0.5%	105	19,639	8.8%
Mill City	1,060	237,466	0	0	0%	25	3,349	1.4%	101	19,374	8.2%
Millersburg	2,049	878,299	0	0	0%	3	291	0%	265	62,011	7.1%
Scio	601	156,690	0	0	0%	1	529	0.3%	15	3,637	2.3%
Sodaville	271	48,953	21	3,624	7.4%	13	2,207	4.5%	147	24,404	50%
Sweet Home	6,313	1,466,569	70	12,479	0.9%	100	21,256	1.4%	757	164,376	11%
Tangent	1,064	407,086	0	0	0%	0	0	0%	8	2,625	0.6%
Waterloo	203	32,851	0	0	0%	0	0	0%	7	702	2.1%
Total	94,241	26,844,514	3,209	693,507	2.6%	3,504	782,288	2.9%	11,842	2,632,249	9.8%

Table B-7. Channel migration exposure

(all dollar amounts in thousands)

Community*	Total Number of Buildings	Total Population	Total Estimated Building Value ($)	Channel Migration Hazard: Potentially Displaced Residents from channel migration Exposure	Channel Migration Hazard: % Potentially Displaced Residents from channel migration Exposure	Channel Migration Hazard: Number of Buildings Exposed	Channel Migration Hazard: Building Value ($)	Channel Migration Hazard: Ratio of Exposure Value
Unincorp. Linn Co (rural)	45,792	35,839	12,020,435	290	0.8%	324	79,728	0.7%
Gates	326	493	70,923	33	6.6%	27	6,929	9.8%
Lyons	1,074	1,203	223,889	57	4.7%	22	8,509	3.8%
Mill City	1,060	1,671	237,466	128	7.7%	47	14,463	6.1%
Total Study Area	48,252	39,206	12,552,713	508	1.3%	420	109,629	0.9%

*Communities in table limited to communities within the study area of Appleby and others (2021).

Table B-8. Wildfire exposure.

(all dollar amounts in thousands)

Community	Total Number of Buildings	Total Estimated Building Value ($)	High Hazard			Moderate Hazard			Low Hazard		
			Number of Buildings	Building Value ($)	Percent of Building Value Exposed	Number of Buildings	Building Value ($)	Percent of Building Value Exposed	Number of Buildings	Building Value ($)	Percent of Building Value Exposed
Unincorp. Linn Co	45,792	12,020,435	175	39,650	0%	2,076	400,106	3%	43,541	11,580,679	96%
Cascadia	231	27,896	21	2,051	7%	150	19,342	69%	60	6,503	23%
Crabtree	459	97,309	0	0	0%	12	1,198	1%	447	96,111	99%
Crawfordsville	374	80,383	0	0	0%	67	10,906	14%	307	69,477	86%
Holley	380	79,188	0	0	0%	8	956	1%	372	78,232	99%
Lacomb	535	126,968	0	0	0%	10	2,040	2%	525	124,928	98%
Peoria	136	25,591	0	0	0%	0	0	0%	136	25,591	100%
Shedd	248	107,103	0	0	0%	0	0	0%	248	107,103	100%
West Scio	198	52,104	0	0	0%	0	0	0%	198	52,104	100%
Total Unincorp. County	48,351	12,616,823	196	41,701	0%	2,323	434,548	3%	45,832	12,140,575	96%
Albany	20,286	7,004,487	0	0	0%	73	46,900	1%	20,213	6,957,587	99%
Brownsville	1,326	284,607	1	377	0.1%	69	19,474	7%	1,256	264,757	93%
Gates	326	70,923	22	5,249	7%	24	5,763	8%	280	59,911	84%
Halsey	602	182,922	0	0	0%	15	2,534	1.4%	587	180,389	99%
Harrisburg	1,924	544,762	0	0	0%	76	22,789	4.2%	1,848	521,973	96%
Lebanon	8,789	2,688,032	0	0	0%	153	54,052	2.0%	8,636	2,633,980	98%
Lyons	1,074	223,889	17	2,553	1.1%	177	29,417	13%	880	191,918	86%
Mill City	1,060	237,466	3	732	0.3%	150	32,445	14%	907	204,289	86%
Millersburg	2,049	878,299	0	0	0%	0	0	0%	2,049	878,299	100%
Scio	601	156,690	0	0	0%	7	1,996	1.3%	594	154,695	99%
Sodaville	271	48,953	0	0	0%	15	2,238	4.6%	256	46,715	95%
Sweet Home	6,313	1,466,569	84	16,365	1.1%	432	84,461	5.8%	5,797	1,365,743	93%
Tangent	1,064	407,086	0	0	0%	32	7,049	1.7%	1,032	400,036	98%
Waterloo	203	32,851	0	0	0%	2	370	1.1%	201	32,481	99%
Total	94,241	26,844,514	323	66,977	0.2%	3,548	744,035	2.8%	90,370	26,033,502	97%

Table B-9. Volcanic lahar hazard exposure.

Community	Total Number of Buildings	Total Estimated Building Value ($)	Small: (100 to 1,000-yr)			Medium: (1,000 to 15,000-yr)			Large: (>15,000-yr)		
			Number of Buildings	Loss Estimate	Percent of Building Value Exposed	Number of Buildings	Loss Estimate	Percent of Building Value Exposed	Number of Buildings	Loss Estimate	Percent of Building Value Exposed
Unincorp. Linn Co (rural)	45,792	12,020,435	67	11,771	0.1%	69	12,207	0.1%	1038	273,507	2.3%
Gates	326	70,923	0	0	0%	0	0	0%	216	49139	69%
Lyons	1,074	223,889	0	0	0%	0	0	0%	0	0	0%
Mill City	1,060	237,466	0	0	0%	0	0	0%	1059	237016	99%
Total	48,252	12,552,713	67	11,771	0.1%	69	12,207	0.1%	2313	559,662	4.5%

*Communities in table limited to communities within the study area of Walder and others (1999).

APPENDIX C. VULNERABILITY ASSESSMENT OF LIFELINES

Table C-1. Inventory of Linn County high hazard potential dams.

Dam name	NID ID	Hazard Potential	Owner/Operator	State Regulated	Purpose
Sullivan Pond 3	OR04077	Significant	Private	Yes	Irrigation
Helms Reservoir	OR00455	Low	Private	Yes	Irrigation
Macedo Dairy Lagoon	OR03060	Low	Private	Yes	Other
American Can Dams (Lagoon)	OR00752	Low	Private	Yes	Other
Foster Log Pond	OR00159	High	Private	Yes	Other
Canal Intake	OR04067	Significant	Local Government	No	Water Supply
Trail Bridge Saddle Dike	OR00540	High	Public Utility	No	Hydroelectric
Smith Dam	OR00541	High	Public Utility	No	Hydroelectric
Lebanon Dam	OR04067	Low	Local Government	No	Water Supply
Trail Bridge	OR00540	High	Public Utility	No	Hydroelectric
Carmen Diversion	OR00539	Low	Public Utility	No	Hydroelectric
Green Peter Dam	OR00010	High	Federal	No	Flood Risk Reduction
Detroit Dam	OR00004	High	Federal	No	Flood Risk Reduction
Foster Dam	OR00012	High	Federal	No	Flood Risk Reduction

Table C-2. Inventory of Linn County Bridges

Bridge Name	Stream Name	Scour Risk from Flooding	Liquefaction High and Very High Susceptibility	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Volcanic Lahar - 1% Annual Chance
		Exposed	Exposed	Exposed	Exposed	Exposed	Exposed
Santiam River Oflow, Hwy 164 at MP 6.98	Santiam River Oflow	-	X	-	-	-	-
Santiam River Oflow, Hwy 164 at MP 7.12	Santiam River OFlow #4	X	X	-	-	-	-
North Santiam River, Hwy 211 (Mehama)	North Santiam River	X	X	-	X	-	-
Calapooia Bottoms, Hwy 58 at MP 11.19	Calapooia Bottom No. 2	-	X	-	-	-	-
Calapooia Bottoms, Hwy 58 at MP 13.96	Calapooia Bottoms No. 7	-	X	-	-	-	-
Willamette River, Hwy 31 EB (Ellsworth St)	Willamette River	X	X	-	-	-	-
Wiley Creek, Hwy 16	Wiley Creek	-	-	X	-	-	-
South Santiam River. McDowell Creek Rd	SOUTH SANTIAM RIVER	-	X	-	-	-	-
Santiam River, Hwy 164	Santiam River	-	X	-	X	-	-
South Santiam River, Hwy 211	South Santiam River	X	X	-	-	-	-
Sheep Creek, Hwy 16	Sheep Creek	-	-	X	-	-	-
Santiam River, Hwy 162 Conn Rt	North Santiam River	-	-	-	X	-	-
South Santiam River, County Rd 721	SOUTH SANTIAM RIVER	X	X	-	-	-	-
Calapooia River, Hwy 58	Calapooia River	X	X	-	-	-	-
Calapooia River, Main St	CALAPOOIA RIVER	X	X	-	-	-	-

Bridge Name	Stream Name	Scour Risk from Flooding	Liquefaction High and Very High Susceptibility	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Volcanic Lahar - 1% Annual Chance
		Exposed	Exposed	Exposed	Exposed	Exposed	Exposed
Hwy 58 over City Street & UPRR	City Street & UPRR	-	-	-	-	-	-
North Santiam River, Sorbin Ave	NORTH SANTIAM RIVER	-	-	X	X	-	X
Willamette River, Hwy 210 EB (Van Buren Ave)	Willamette River	X	X	-	-	-	-
North Fork Santiam River, Jefferson Scio Dr	N FORK SANTIAM RIVER	-	X	-	X	-	-
South Santiam River, Berlin Rd	SOUTH SANTIAM RIVER	-	X	-	-	-	-
Santiam River, Hwy 1 SB	Santiam River	-	X	-	X	-	-
Dever-Conner Road over Hwy 1	I-5 (Hwy 1)	-	X	-	-	-	-
Viewcrest Rd over Hwy 1	I-5 (HWY 1)	-	-	-	-	-	-
Hwy 16 over Hwy 1 & Conns	I-5 (Hwy 1)	-	-	-	-	-	-
Grand Prairie Drive over Hwy 1	I-5 (HWY 1)	-	-	-	-	-	-
Seven Mile Lane over Hwy 1	I-5 (HWY 1)	-	-	-	-	-	-
Hwy 210 over Hwy 1	I-5 (Hwy 1)	X	-	-	-	-	-
Willamette River, Hwy 210 WB (Harrison Blvd)	Willamette River	X	X	-	-	-	-
Willamette River, Hwy 31 WB (Lyon St)	Willamette River	X	X	-	-	-	-
Calapooia River, Hwy 210	Calapooia River	X	X	-	-	-	-
Muddy Creek, Oakville Rd	MUDDY CREEK	X	X	-	-	-	-
Little Muddy Creek, Rowland Rd	LITTLE MUDDY CREEK	X	X	-	-	-	-
Calapooia River, Calapooia River Rd	CALAPOOIA RIVER	X	-	-	-	-	-
Green Peter Reservoir, Quartzville Dr	GREEN PETER RESERVOIR	X	-	-	-	-	-
Muddy Creek, Fayetteville Dr	MUDDY CREEK	X	X	-	-	-	-
Overflow, Boston Mill Rd at MP 5.57	OVERFLOW	X	X	-	-	-	-
Santiam River, Hwy 1 NB	Santiam River	-	X	-	X	-	-
Hwy 1 NB over UPRR & Hwy 164	UPRR & Hwy 164	-	X	-	-	-	-
Santiam Oflow No 6, Hwy 1 NB at MP 239.85	Santiam Overflow No. 6	-	X	-	-	-	-
Whitewater Creek, Hwy 162	Whitewater Creek	-		-	-	-	X
Santiam Oflow No 6, Hwy 1 SB at MP 239.85	Santiam Overflow No. 6	-	X	-	-	-	-
Hwy 1 SB over UPRR & Hwy 164	UPRR & Hwy 164	-	X	-	-	-	-
South Santiam River, Grant St	SOUTH SANTIAM RIVER	-	X	-	-	-	-
Sodom Ditch, Hwy 1 NB	Sodom Ditch	-	X	-	-	-	-
Sodom Ditch, Hwy 1 SB	Sodom Ditch	-	X	-	-	-	-
Middle Fork Santiam River, Quartzville Dr	MIDDLE FORK SANTIAM R.	X	-	-	-	-	-
South Santiam River, Quartzville Rd	SOUTH SANTIAM RIVER	-	X	-	-	-	-

Table C-3. Lifeline Risk by Linn County Community

Lifeline by Community	UDF ID	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Mill Creek and Turner Fault Mw 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
		Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
UNINCORPORATED COUNTY						
High-occupancy building	113768					
Fuel Supply	175658					
Fuel Supply	179149		X			
Communication	143044					
Communication	147709			X		
Communication	121952					
Communication	169548					X
Communication	115026					
Communication	182231					
Communication	162089					X
Communication	161255					
Communication	176338					X
Communication	186154					X
Communication	186004					
Communication	173615					
Communication	174433	X				
Communication	291165				X	
Communication	176188					
ALBANY						
Elder Care	134986					
Financial Institution	146001			X		
Financial Institution	131712		X			
Financial Institution	133483					
Financial Institution	140100					
Financial Institution	140342		X	X		
Financial Institution	140186		X	X		
Financial Institution	140052					
Elder Care	126506		X			
Elder Care	130864					
Elder Care	136609					
Elder Care	137389					
Financial Institution	140026					
Financial Institution	139877		X	X		
Financial Institution	146156		X			
Elder Care	125871		X			
Elder Care	139223					
Elder Care	180205		X			
Elder Care	136719					

Lifeline by Community	UDF ID	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Mill Creek and Turner Fault Mw 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
		Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Elder Care	132354		X	X		
Elder Care	189553			X		
Financial Institution	137586		X	X		
Financial Institution	137655		X			
Elder Care	132793					
CRAWFORDSVILLE						
Financial Institution	166695					
HALSEY						
Church	171597					
Fuel Supply	171711					
HARRISBURG						
Church	170032					
Financial Institution	170157					
LEBANON						
Elder Care	138068					
Community Center	104687					
Elder Care	113518					
Elder Care	106548					
Elder Care	112905					
Financial Institution	108433		X	X		
Financial Institution	108525					
Financial Institution	104476			X		
Elder Care	106562			X		
Financial Institution	108022					
Financial Institution	190602					
Food Distribution	110190		X	X		
Communications	191165					
Elder Care	110615					
Communications	105661					
Financial Institution	109254			X		
Financial Institution	113623					
Financial Institution	180113					
Elder Care	107961					
Elder Care	190379					
Financial Institution	108105			X		
Financial Institution	104835			X		
Financial Institution	113984		X	X		
LYONS						
High-occupancy Building	114515		X			X
US Post Office	114583					
Church	114822					

Lifeline by Community	UDF ID	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Mill Creek and Turner Fault Mw 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
		Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Church	114833					
High-occupancy Building	114947					
MILLERSBURG						
Communications	146586			X		
SODAVILLE						
Church	153367					
Church	166090					
SWEET HOME						
Elder Care	158115					
Elder Care	160042				X	
Financial Institution	157358					
Financial Institution	157710					
Financial Institution	157923					
Financial Institution	158240					
Financial Institution	158317					
TANGENT						
High-occupancy Building	149484					
WATERLOO						
Food Distribution	152997		X	X		
Church	154516					

APPENDIX D. HAZUS METHODOLOGY

D.1 Software

We performed all loss estimations using Hazus®-MH 5.0 and ArcGIS® Pro 3.0.0.

D.2 User-Defined Facilities (UDF) Database

A UDF database was compiled for all buildings in Linn County for use in both the flood and earthquake modules of Hazus. The Linn County assessor database (acquired in 2023) was used to determine which taxlots had improvements (i.e., buildings) and how many building points should be included in the UDF database.

D.2.1 Locating buildings points

The Oregon Department of Geology and Mineral Industries (DOGAMI) used the SBFO-1 (Williams, 2021) dataset to help precisely locate the centroid of each building. Extra effort was spent to locate building points along the 1% and 0.2% annual chance inundation fringe. When buildings were partially within the inundation zone, the building point was moved to the centroid of the portion of the building within the inundation zone. An iterative approach was used to further refine locations of building points for the flood module by generating results, reviewing the highest value buildings, and moving the building point over a representative elevation on the lidar digital elevation model to ensure an accurate first floor height.

D.2.2 Attributing building points

Populating the required attributes for Hazus was achieved through a variety of approaches. The Linn County assessor database was used whenever possible, but in many cases that database did not provide the necessary information. The following is list of attributes and their sources:

- **Longitude** and **Latitude** – Location information that provides Hazus the x and y-position of the UDF point. This allows for an overlay to occur between the UDF point and the flood or earthquake input data layers. The hazard model uses this spatial overlay to determine the correct hazard risk level that will be applied to the UDF point. The format of the attribute must be in decimal degrees. A simple geometric calculation using GIS software is done on the point to derive this value.
- **Occupancy class** – An alphanumeric attribute that indicates the use of the UDF (e.g. 'RES1' is a single family dwelling). The alphanumeric code is composed of seven broad occupancy types (RES = residential, COM = commercial, IND = industrial, AGR = agricultural, GOV = public, REL = non-profit/religious, EDU = education) and various suffixes that indicate more specific types. This code determines the damage function to be used for flood analysis. It is also used to attribute the Building Type field, discussed below, for the earthquake analysis. The code was interpreted from "Stat Class" or "Description" data found in the Linn County assessor database. When data was not available, the default value of RES1 was applied throughout.
- **Cost** – The replacement cost of an individual UDF. Loss ratio is derived from this value. Replacement cost is based on a method called RSMeans valuation (Charest, 2017) and is calculated by multiplying the building square footage by a standard cost per square foot. These standard rates per square foot are in tables within the default Hazus database.

- **Year built** – The year of construction that is used to attribute the Building Design Level field for the earthquake analysis (see "Building Design" below). The year a UDF was built is obtained from Linn County assessor database. When not available, the year of "1900" was applied.
- **Square feet** – The size of the UDF is used to pro-rate the total improvement value for taxlots with multiple UDFs. The value distribution method will ensure that UDFs with the highest square footage will be the most expensive on a given taxlot. This value is also used to pro-rate the **Number of People** field for Residential UDFs within a census block. The value was obtained from DOGAMI's building footprints; where (RES) footprints were not available, we used the Linn County assessor database.
- **Number of stories** – The number of stories for an individual UDF, along with Occupancy Class, determines the applied damage function for flood analysis. The value was obtained from the Linn County assessor database when available. For UDFs without assessor information for number of stories that are within the flood zone, closer inspection using Google Street View™ or available oblique imagery was used for attribution.
- **Foundation type** – The UDF foundation type correlates with First Floor Height values in feet (see Table 3.11 in the Hazus Technical Manual for the Flood Model [FEMA, 2022a]). It also functions within the flood model by indicating if a basement exists or not. UDFs with a basement have a different damage function from UDFs that do not have one. The value was obtained from the Linn County assessor database when available. For UDFs without assessor information for basements that are within the flood zone, closer inspection using Google Street View™ or available oblique imagery was used to ascertain if one exists or not.
- **First floor height** – The height in feet above grade for the lowest habitable floor. The height is factored during the depth of flooding analysis. The value is used directly by Hazus, where Hazus overlays a UDF location on a depth grid and using the **first-floor height** determines the level of flooding occurring to a building. It is derived from the Foundation Type attribute or observation via oblique imagery or Google Street View™ mapping service.
- **Building type** – This attribute determines the construction material and structural integrity of an individual UDF. It is used by Hazus for estimating earthquake losses by determining which damage function will be applied. This information was unavailable from the Linn County assessor data, so instead it was derived from a statistical distribution based on **Occupancy class**.
- **Building design level** – This attribute determines the seismic building code for an individual UDF. It is used by Hazus for estimating earthquake losses by determining which damage function will be applied. This information is derived from the **Year Built** attribute (Linn County Assessor) and state/regional Seismic Building Code benchmark years.
- **Number of people** – The estimated number of permanent residents living within an individual residential structure. It is used in the post-analysis phase to determine the amount of people affected by a given hazard. This attribute is derived from default Hazus database (United States Census Bureau, 2020a) of population per census block and distributed across residential UDFs and adjusted based on population growth estimates from PSU Population Research Center.
- **Community** – The community that a UDF is within. These areas are used in the post-analysis for reporting results. The communities were based on incorporated area boundaries; unincorporated community areas were based on building density.

D.2.3 Seismic building codes

Oregon initially adopted seismic building codes in the mid-1970s (Judson, 2012). The established benchmark years of code enforcement are used in determining a "design level" for individual buildings. The design level attributes (pre code, low code, moderate code, and high code) are used in the Hazus earthquake model to determine what damage functions are applied to a given building (FEMA, 2022b). The year built or the year of the most recent seismic retrofit are the main considerations for an individual design level attribute. Seismic retrofitting information for structures would be ideal for this analysis but was not available for Linn County. **Table D-1** outlines the benchmark years that apply to buildings within Linn County.

Table D-1. Linn County seismic design level benchmark years.

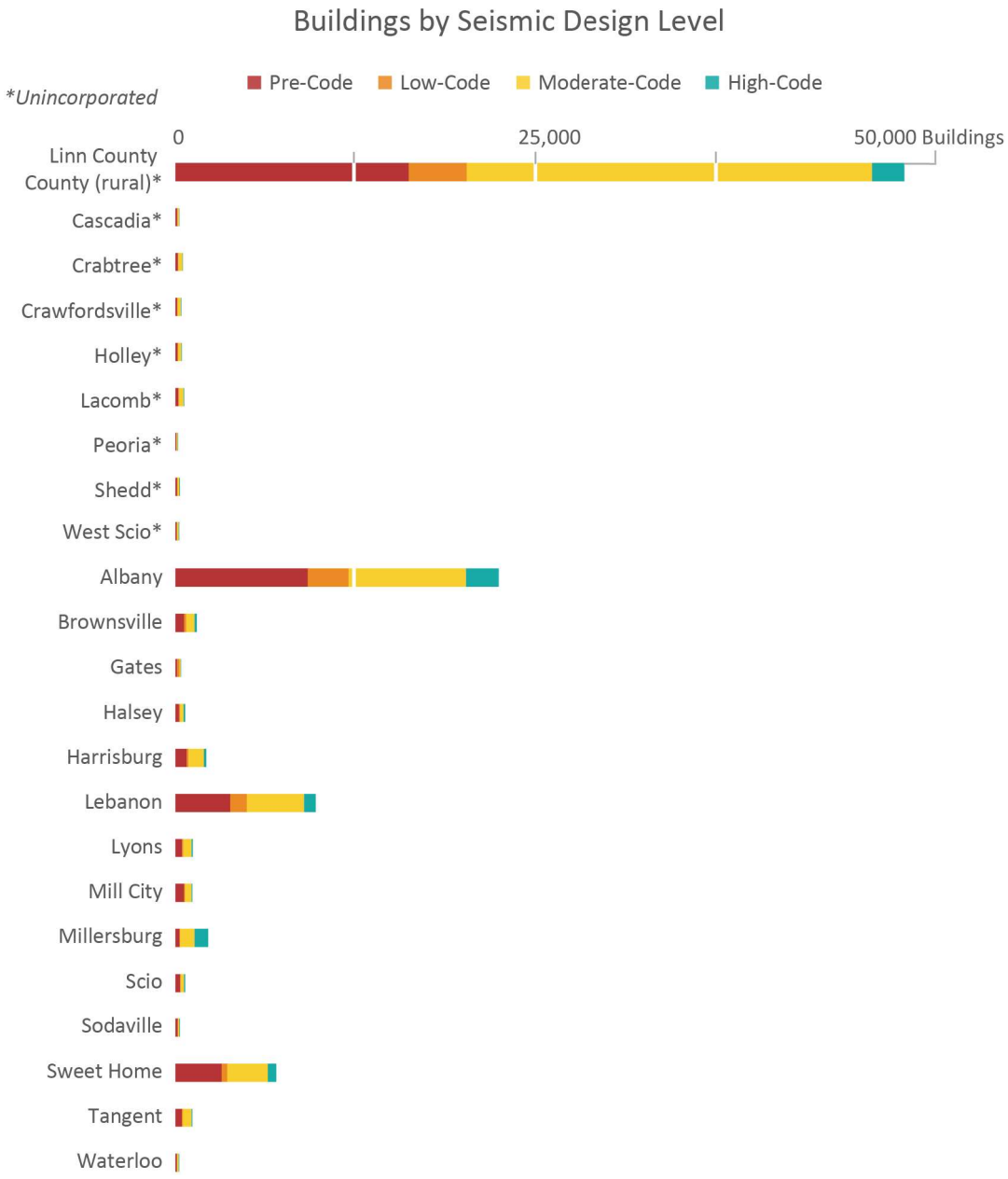
Building Type	Year Built	Design Level	Basis
Single-Family Dwelling (includes Duplexes)	prior to 1976	Pre Code	Interpretation of Judson (Judson, 2012)
	1976–1991	Low Code	
	1992–2003	Moderate Code	
	2004–2016	High Code	
Manufactured Housing	prior to 2003	Pre Code	Interpretation of OR BCD 2002 Manufactured Dwelling Special Codes (Oregon Building Codes Division, 2002)
	2003–2010	Low Code	
	2011–2016	Moderate Code	Interpretation of OR BCD 2010 Manufactured Dwelling Special Codes Update (Oregon Building Codes Division, 2010)
All other buildings	prior to 1976	Pre Code	Business Oregon 2024 Oregon Benefit-Cost Analysis Tool, p. 24 (Business Oregon, 2024)
	1976–1990	Low Code	
	1991–2016	Moderate Code	

Table D-2 and corresponding **Figure D-1** illustrate the current state of seismic building codes for the county.

Table D-2. Seismic design level in Linn County.

		Pre Code		Low Code		Moderate Code		High Code	
Community	Total Number of Buildings	Number of Buildings	Percentage of Buildings	Number of Buildings	Percentage of Buildings	Number of Buildings	Percentage of Buildings	Number of Buildings	Percentage of Buildings
Unincorp. Linn Co	45,792	14,624	32%	3,653	8.0%	25,471	55.6%	2,044	4.5%
Cascadia	231	109	47%	21	9.1%	96	41.6%	5	2.2%
Crabtree	459	148	32%	25	5.4%	274	59.7%	12	2.6%
Crawfordsville	374	115	31%	14	3.7%	226	60.4%	19	5.1%
Holley	380	126	33%	30	7.9%	202	53.2%	22	5.8%
Lacomb	535	180	34%	50	9.3%	277	51.8%	28	5.2%
Peoria	136	63	46%	9	6.6%	57	41.9%	7	5.1%
Shedd	248	120	48%	6	2.4%	115	46.4%	7	2.8%
West Scio	198	75	38%	2	1.0%	119	60.1%	2	1.0%
Total Unincorp. County	48,351	15,560	32%	3,810	7.9%	26,835	55.5%	2,146	4.4%
Albany	20,286	8,305	41%	2,554	12.6%	7,365	36.3%	2,062	10.2%
Brownsville	1,326	539	41%	132	10.0%	530	40.0%	125	9.4%
Gates	326	104	32%	144	44.2%	74	22.7%	4	1.2%
Halsey	602	225	37%	63	10.5%	232	38.5%	82	13.6%
Harrisburg	1,924	693	36%	128	6.7%	966	50.2%	137	7.1%
Lebanon	8,789	3,440	39%	1,048	11.9%	3,588	40.8%	713	8.1%
Lyons	1,074	417	39%	60	5.6%	527	49.1%	70	6.5%
Mill City	1,060	532	50%	84	7.9%	389	36.7%	55	5.2%
Millersburg	2,049	247	12%	58	2.8%	880	42.9%	864	42.2%
Scio	601	297	49%	55	9.2%	173	28.8%	76	12.6%
Sodaville	271	149	55%	14	5%	97	35.8%	11	4.1%
Sweet Home	6,313	2,885	46%	376	6%	2,531	40%	521	8%
Tangent	1,064	395	37%	73	7%	534	50%	62	6%
Waterloo	203	93	46%	4	2%	96	47%	10	5%
Total	94,241	33,881	36%	8,603	9%	44,819	48%	6,938	7%

Figure D-1. Seismic design level by Linn County community.



D.3 Flood Hazard Data

Depth grids for "Zone A" designated flood zones, or approximate 100-year flood zones, were developed by the Strategic Alliance for Risk Reduction (STARR) in 2015 to revise the Linn County FIRMs (FEMA, 2016). DOGAMI developed depth grids from detailed stream model information within the study area. Both sets of depth grids were used in this risk assessment to determine the level to which buildings are impacted by flooding.

A study area-wide, 2-meter, lidar-based depth grid was developed for each of the 10-, 50-, 100-, and 500-year annual chance flood events. The depth grids were imported into Hazus for determining the depth of flooding for areas within the FEMA flood zones.

Once the UDF database was developed into a Hazus-compliant format, the Hazus methodology was applied using a Python (programming language) script developed by DOGAMI (Bauer, 2018). The analysis was then run for a given flood event, and the script cross-referenced a UDF location with the depth grid to find the depth of flooding. The script then applied a specific damage function, based on a UDF's Occupancy Class [OccCls], which was used to determine the loss ratio for a given amount of flood depth, relative to the UDF's first-floor height.

D.4 Earthquake Hazard Data

The following hazard layers used for our loss estimation are derived from work conducted by Madin and others (2021): National Earthquake Hazard Reduction Program (NEHRP) soil classification, liquefaction susceptibility and wet landslide susceptibility. The liquefaction and landslide susceptibility layers together with NEHRP were used by the Hazus tool to calculate ground motion layers and permanent ground deformation and associated probability. The default value of 5 feet was used for the water table depth value.

During the Hazus earthquake analysis, each UDF was analyzed given its site-specific parameters (ground deformation) and evaluated for loss, expressed as a probability of a damage state. Specific damage functions based on Building type and Building design level were used to calculate the damage states given the site-specific parameters for each UDF. The output provided probabilities of the five damage states (None, Slight, Moderate, Extensive, Complete) from which losses in dollar amounts were derived.

D.5 Post-Analysis Quality Control

Ensuring the quality of the results from Hazus flood and earthquake modules is an essential part of the process. A primary characteristic of the process is that it is iterative. A UDF database without errors is highly unlikely, so this part of the process is intended to limit and reduce the influence these errors have on the final outcome. Before applying the Hazus methodology, closely examining the top 10 largest area UDFs and the top 10 most expensive UDFs is advisable. Special consideration can also be given to critical facilities due to their importance to communities.

Identifying, verifying, and correcting (if needed) the outliers in the results is the most efficient way to improve the UDF database. This can be done by sorting the results based on the loss estimates and closely scrutinizing the top 10 to 15 records. If corrections are made, then subsequent iterations are necessary. We continued checking the "loss leaders" until no more corrections were needed.

Finding anomalies and investigating possible sources of error are crucial in making corrections to the data. A wide range of corrections might be required to produce a better outcome. For example, floating homes may need to have a first-floor height adjustment or a UDF point position might need to be moved due to issues with the depth grid. Incorrect basement or occupancy type attribution could be the cause of a problem. Commonly, inconsistencies between assessor data and taxlot geometry can be the source of an error. These are just a few of the many types of problems addressed in the quality control process.

APPENDIX E. ACRONYMS AND DEFINITIONS

E.1 Acronyms

CRS	Community Rating System
CSZ	Cascadia subduction zone
DLCD	Oregon Department of Land Conservation and Development
DOGAMI	Department of Geology and Mineral Industries (State of Oregon)
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRI	Fire Risk Index
GIS	Geographic Information System
NFIP	National Flood Insurance Program
NHMP	Natural hazard mitigation plan
NOAA	National Oceanic and Atmospheric Administration
ODF	Oregon Department of Forestry
OEM	Oregon Emergency Management
OFR	Open-File Report
OPDR	Oregon Partnership for Disaster Resilience
PGA	Peak ground acceleration
PGD	Permanent ground deformation
PGV	Peak ground velocity
Risk MAP	Risk Mapping, Assessment, and Planning
SHMO	State Hazard Mitigation Officer
SLIDO	State Landslide Information Layer for Oregon
UDF	User-defined facilities
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WUI	Wildland-urban interface
WWA	West Wide Wildfire Risk Assessment

E.2 Definitions

1% annual chance flood – The flood elevation that has a 1-percent chance of being equaled or exceeded each year. Sometimes referred to as the 100-year flood.

0.2% annual chance flood – The flood elevation that has a 0.2-percent chance of being equaled or exceeded each year. Sometimes referred to as the 500-year flood.

Base flood elevation (BFE) – Elevation of the 1-percent-annual-chance flood. This elevation is the basis of the insurance and floodplain management requirements of the NFIP.

Critical facilities – Facilities that, if damaged, would present an immediate threat to life, public health, and safety. As categorized in HAZUS, critical facilities include hospitals, emergency operations centers, police stations, fire stations and schools.

Exposure – Determination of whether a building is within or outside of a hazard zone. No loss estimation is modeled.

Flood Insurance Rate Map (FIRM) – An official map of a community, on which FEMA has delineated both the SFHAs and the risk premium zones applicable to the community.

Flood Insurance Study (FIS) – Contains an examination, evaluation, and determination of the flood hazards of a community and, if appropriate, the corresponding water-surface elevations.

Hazus – A GIS-based risk assessment methodology and software application created by FEMA and the National Institute of Building Sciences for analyzing potential losses from floods, hurricane winds, and earthquakes.

Lidar – A remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light. Lidar is popularly used as a technology to make high-resolution maps.

Liquefaction – Describes a phenomenon whereby a saturated soil substantially loses strength and stiffness in response to an applied stress, usually an earthquake, causing it to behave like liquid.

Loss Ratio – The expression of loss as a fraction of the value of the local inventory (total value/loss).

Magnitude – A scale used by seismologists to measure the size of earthquakes in terms of energy released.

Risk – Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of a natural hazard. Sometimes referred to as vulnerability.

Risk MAP – The vision of this FEMA strategy is to work collaboratively with State, local, and tribal entities to deliver quality flood data that increases public awareness and leads to action that reduces risk to life and property.

Riverine – Of or produced by a river. Riverine floodplains have readily identifiable channels.

Susceptibility – Degree of proneness to natural hazards that is determined based on physical characteristics that are present.

Vulnerability – Characteristics that make people or assets more susceptible to a natural hazard.

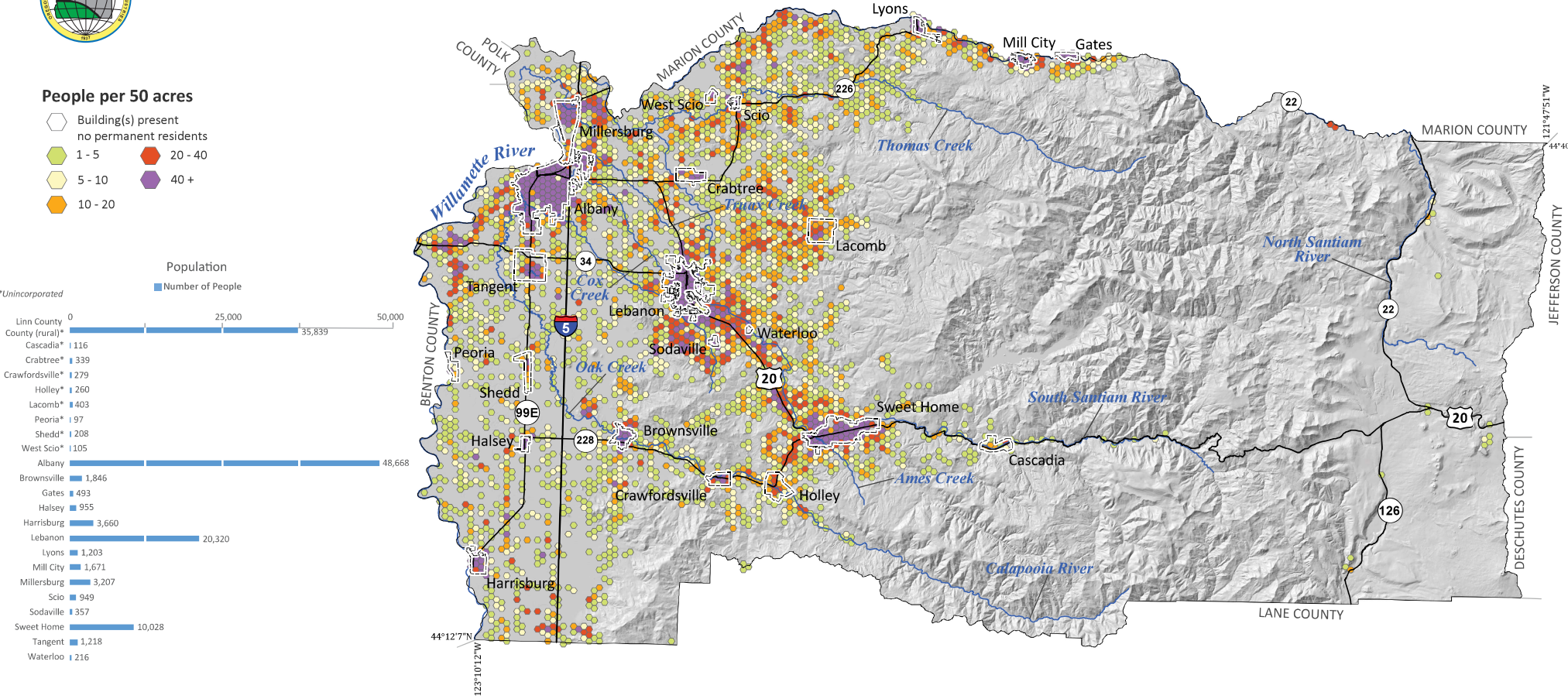
APPENDIX F. MAP PLATES

See appendix folder for individual map PDFs.

Plate 1. Population Density Map of Linn County, Oregon 107
Plate 2. CSZ Mw-9.0 Earthquake Shaking Map of Linn County, Oregon 108
Plate 3. Turner and Mill Creek Fault Mw-6.6 Earthquake Shaking Map of Linn County, Oregon 109
Plate 4. Coseismic Landslide Susceptibility (Wet) Map of Linn County, Oregon 110
Plate 5. Liquefaction Susceptibility Map of Linn County, Oregon 111
Plate 6. Site Amplification Map of Linn County, Oregon 112
Plate 7. Flood Hazard Map of Linn County, Oregon 113
Plate 8. Landslide Susceptibility Map of Linn County, Oregon 114
Plate 9. Channel Migration Hazard Map of Linn County, Oregon 115
Plate 10. Wildfire Risk Map of Linn County, Oregon 116
Plate 11. Lahar Exposure Map of Linn County, Oregon 117

PLATE 1

Population Density Map of Linn County, Oregon



Population

Number of People

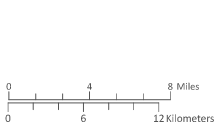
*Unincorporated

Data Sources:
Population data: PSU Population Research Center (2022)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Cartography by: Matt C. Williams, 2024

Study Location Map



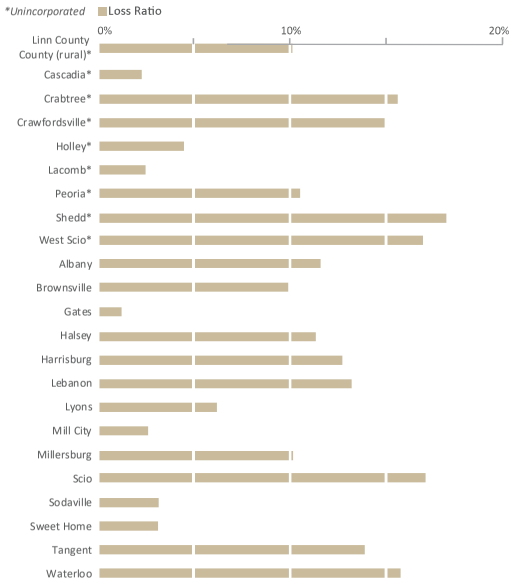
This map is an overview map and not intended to provide details at the community scale. The GIS data that are published with the Linn County Multi-Hazard Risk Assessment can be used to inform regarding queries at the community scale.

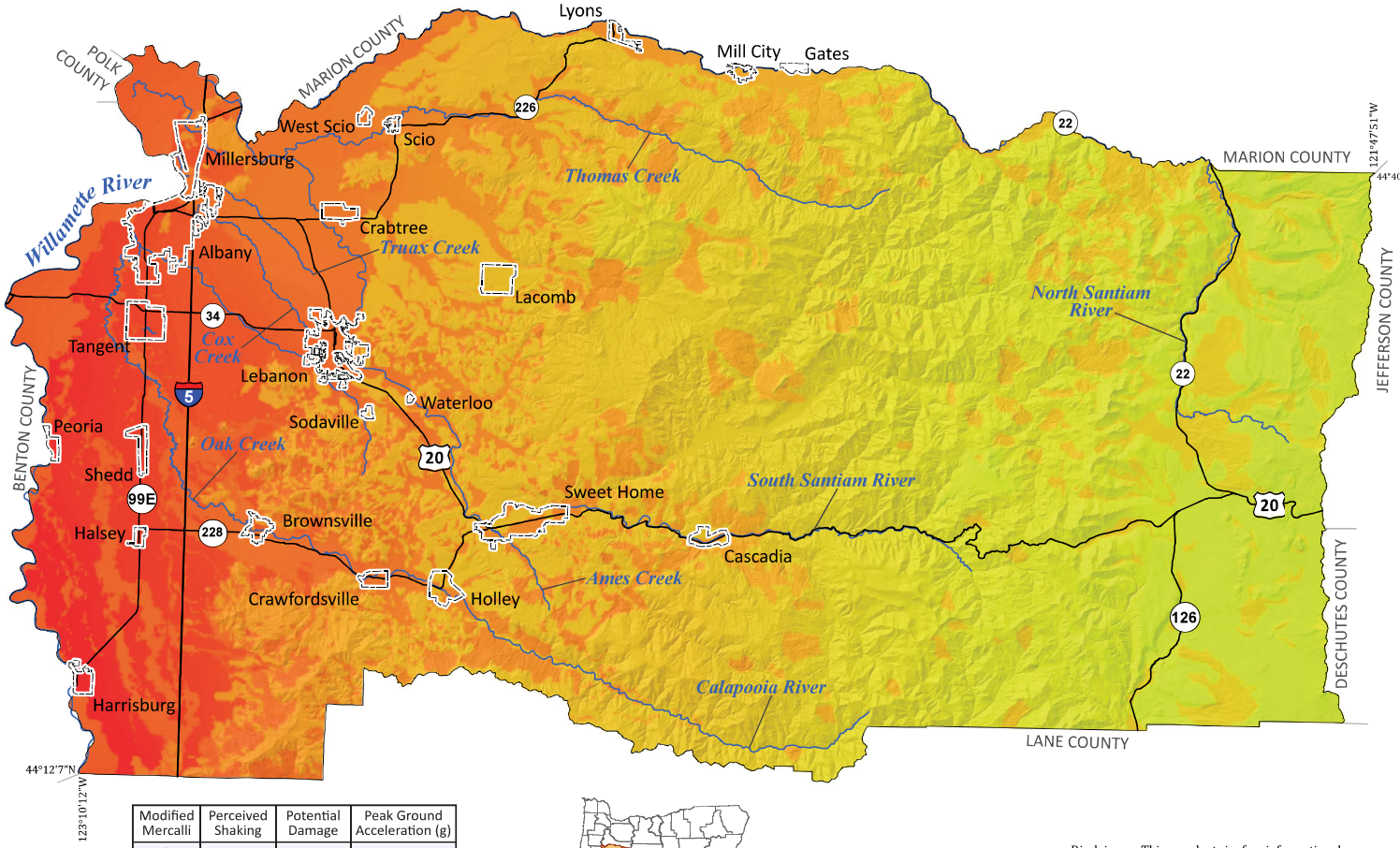
Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information. This publication cannot substitute for site-specific investigations by qualified practitioners. Site-specific data may give results that differ from the results shown in the publication. See the accompanying text report for more details on the limitations of the methods and data used to prepare this publication.

PLATE 2

CSZ Magnitude-9.0 Earthquake Shaking Map of Linn County, Oregon

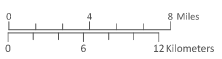
Peak Ground Acceleration (PGA) is the maximum acceleration in a given location or rather how hard the ground is shaking during an earthquake. It is one measurement of ground motion, which is closely associated with the level of damage that occurs from an earthquake.





Modified Mercalli	Perceived Shaking	Potential Damage	Peak Ground Acceleration (g)
I	Not felt	None	< 0.000464
II	Weak	None	0.000464 - 0.00297
III	Weak	None	0.000464 - 0.00297
IV	Light	None	0.00297 - 0.0276
V	Moderate	Very Light	0.0276 - 0.115
VI	Strong	Light	0.115 - 0.215
VII	Very Strong	Moderate	0.215 - 0.401
VIII	Severe	Mod./Heavy	0.401 - 0.747
IX	Violent	Heavy	0.747 - 1.39
X	Extreme	Very Heavy	> 1.39

Study Location Map



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Data Sources:
Earthquake peak ground acceleration: Madin and others (2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

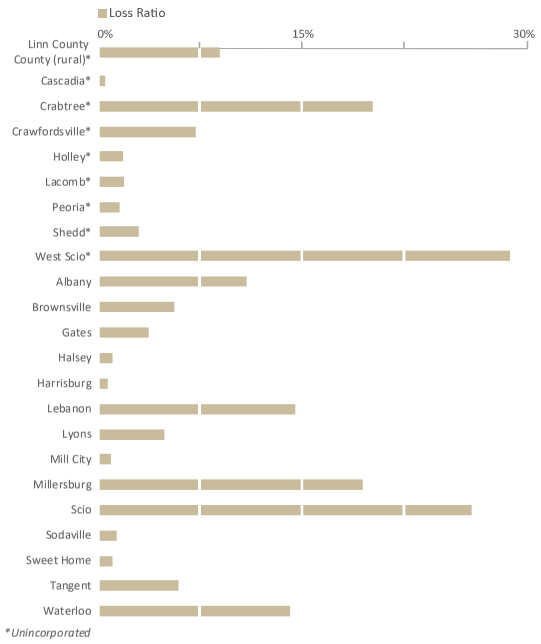
Cartography by: Matt C. Williams, 2023

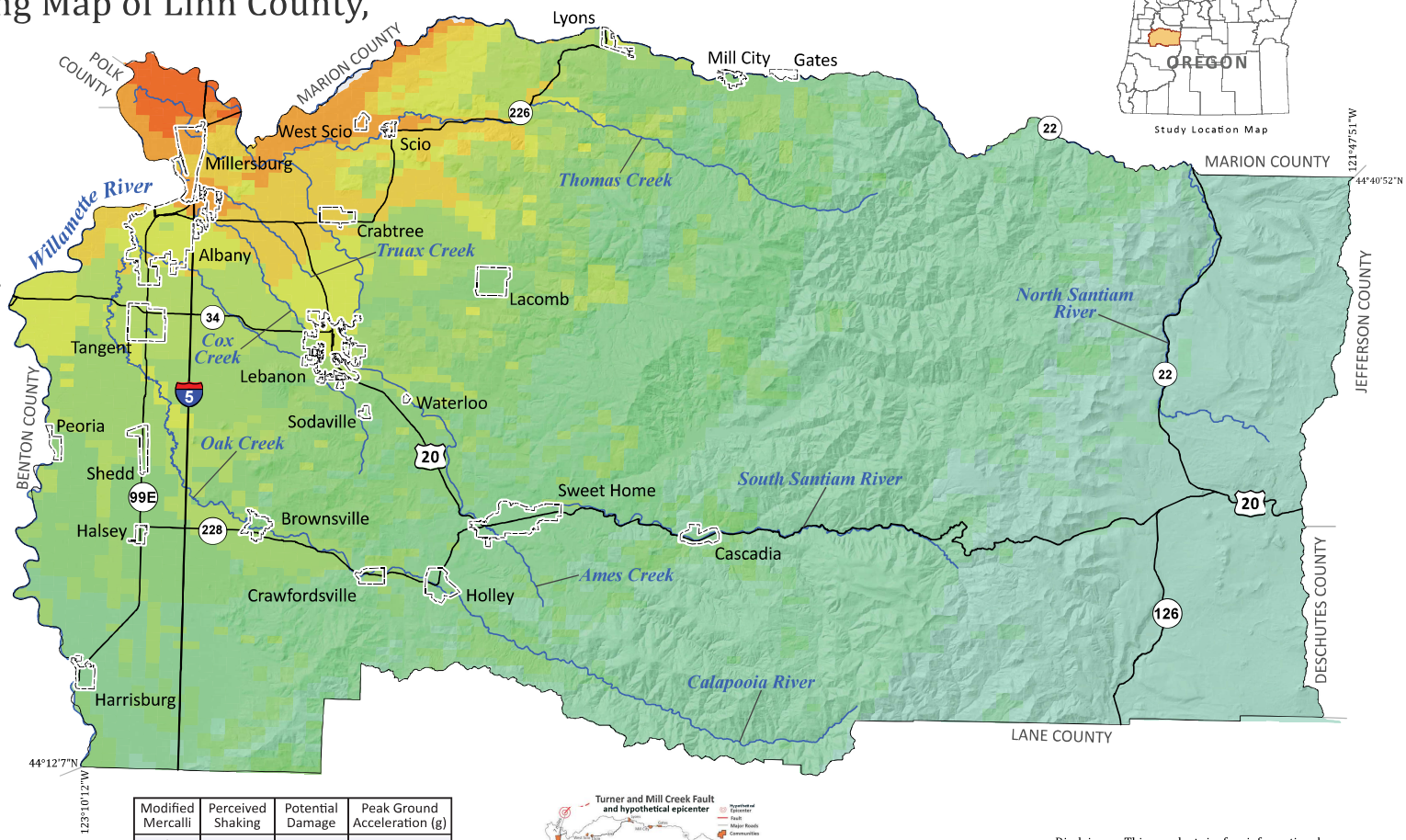
Oregon Department of Geology and Mineral Industries Open-File Report O-24-15

PLATE 3

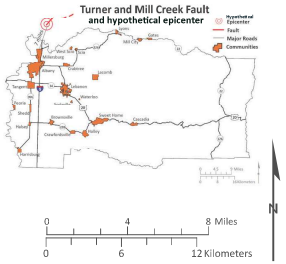
Turner and Mill Creek Fault Magnitude-6.6 Earthquake Shaking Map of Linn County, Oregon

Peak Ground Acceleration (PGA) is the maximum acceleration in a given location or rather how hard the ground is shaking during an earthquake. It is one measurement of ground motion, which is closely associated with the level of damage that occurs from an earthquake.





Modified Mercalli	Perceived Shaking	Potential Damage	Peak Ground Acceleration (g)
I	Not felt	None	< 0.000464
II	Weak	None	0.000464 - 0.00297
III	Weak	None	0.000464 - 0.00297
IV	Light	None	0.00297 - 0.0276
V	Moderate	Very Light	0.0276 - 0.115
VI	Strong	Light	0.115 - 0.215
VII	Very Strong	Moderate	0.215 - 0.401
VIII	Severe	Mod./Heavy	0.401 - 0.747
IX	Violent	Heavy	0.747 - 1.39
X	Extreme	Very Heavy	> 1.39



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Data Sources:
Earthquake peak ground acceleration: Madin and others (2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

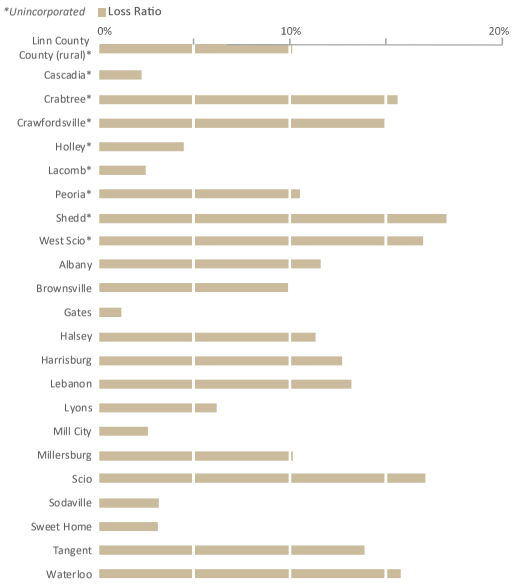
Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

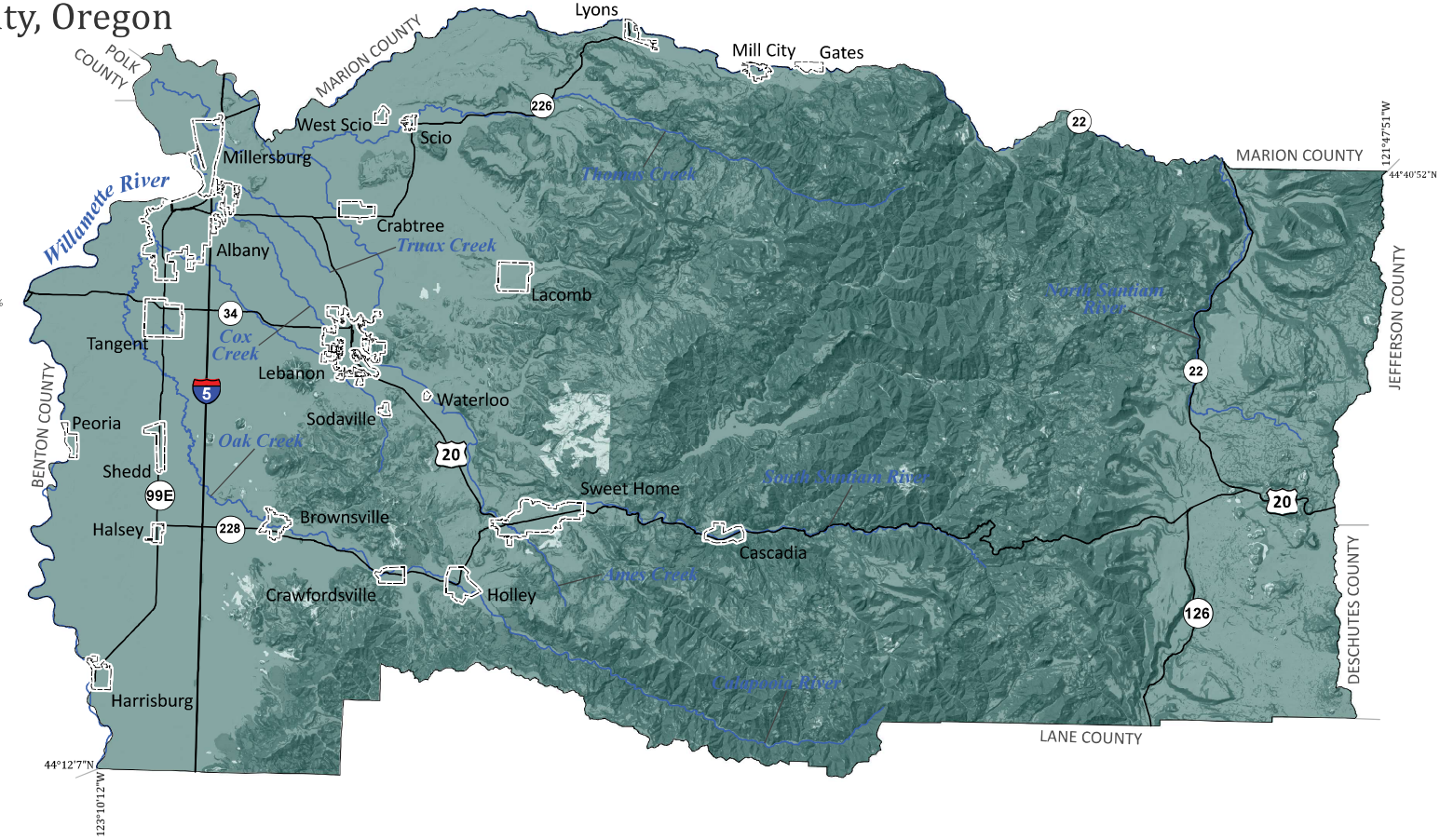
Cartography by: Matt C. Williams, 2023

Oregon Department of Geology and Mineral Industries Open-File Report O-24-15

Coseismic Landslide Susceptibility (Wet) Map of Linn County, Oregon

Coseismic landslide is a type of ground deformation that occurs during an earthquake where slope failure creates a mass movement of rock and debris. Saturated ground increases the susceptibility of a landslide occuring from seismic shaking. Coseismic landslides are a significant factor in the risk from earthquake hazard.





Data Sources:
Coseismic Landslide (wet): Madin and others (2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Cartography by: Matt C. Williams, 2023

Coseismic Landslide Susceptibility (Wet)

0 (None) — 9 (High)

Study Location Map

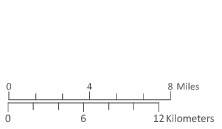


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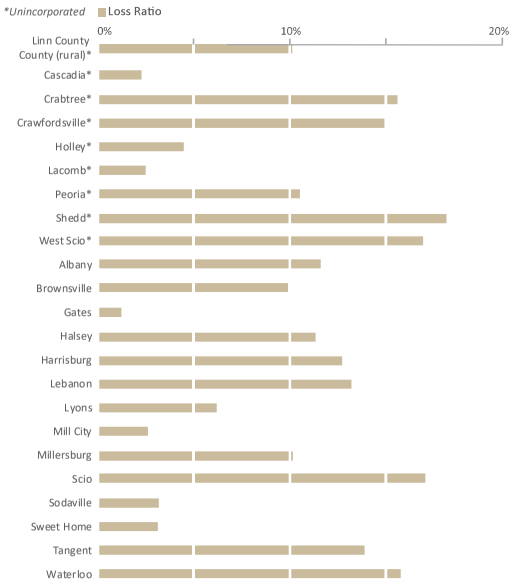
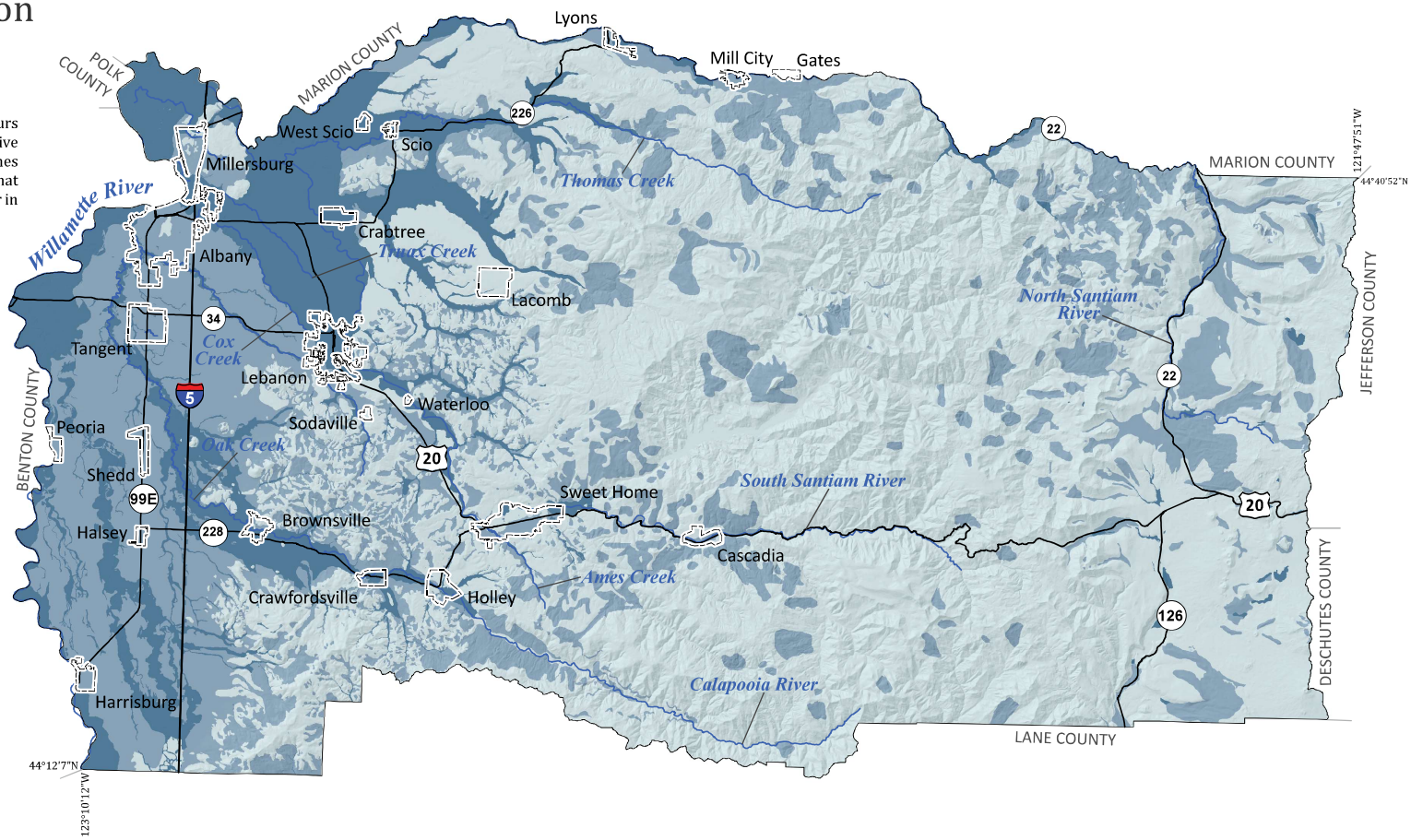
PLATE 5

Liquefaction Susceptibility Map of Linn County, Oregon

Liquefaction is a type of ground deformation that occurs during an earthquake where saturated, non-cohesive soil contracts and liquefies. The ground that becomes liquefied can no longer support heavy structures that are built on top of it. Liquefaction is a significant factor in the risk from earthquake hazard.





Data Sources:
Liquefaction susceptibility: Madin and others (2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Cartography by: Matt C. Williams, 2023

Liquefaction Susceptibility

- Low or None
- Moderate
- High
- Very High

Study Location Map

0 4 8 Miles
0 6 12 Kilometers

N

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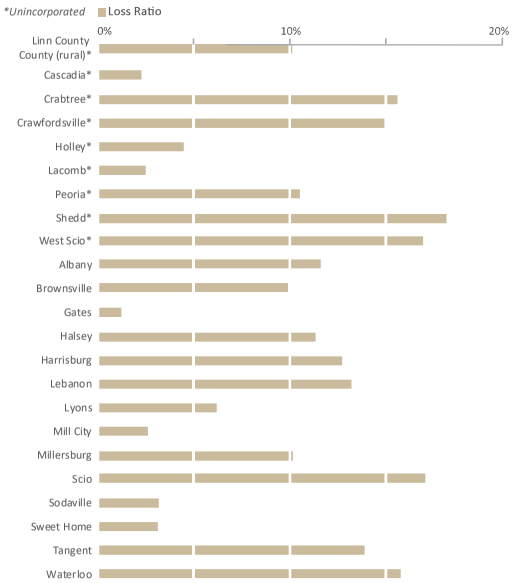
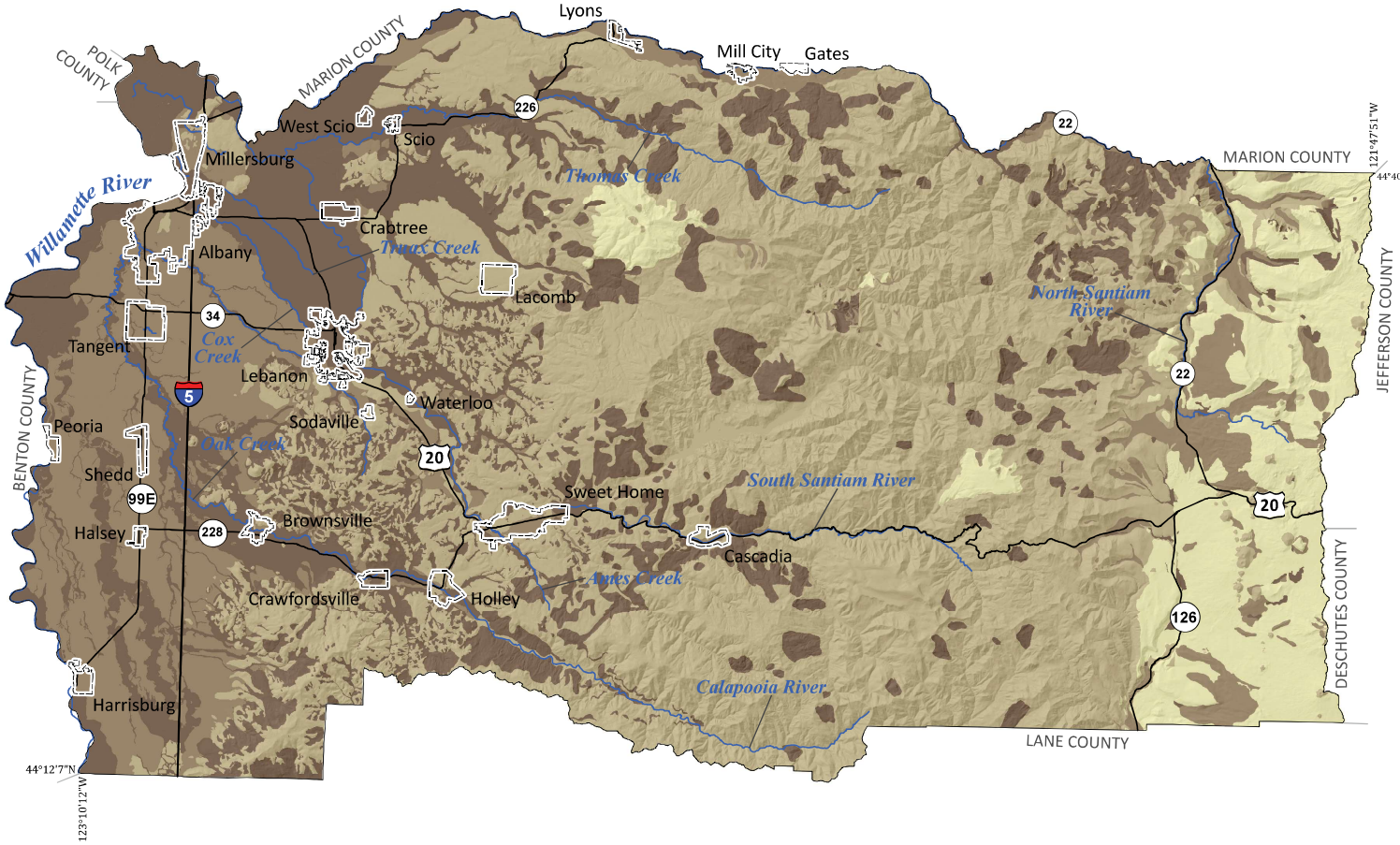
Site Amplification Map of Linn County, Oregon

Site Amplification is the degree to which soil types attenuate (weaken) or amplify (strengthen) seismic waves produced from an earthquake. The National Earthquake Hazards Reduction Program (NEHRP) classifies these geologic units into soft rock (B), dense soil or soft rock (C), stiff soil (D), and soft clay or soil (E, F). NEHRP soils can significantly affect the level of shaking and amount of damage that occurs at a specific location during an earthquake





Data Sources:
Soil amplification: Madin and others (2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

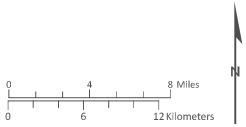
Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Cartography by: Matt C. Williams, 2023

NEHRP Class

- B
- C
- D
- E, F

Study Location Map



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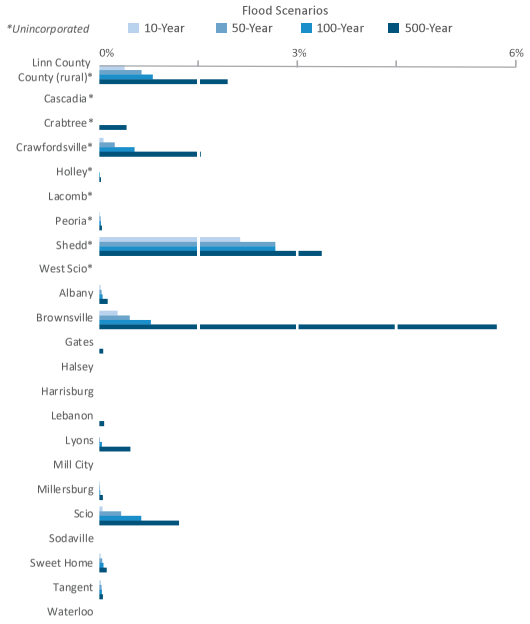
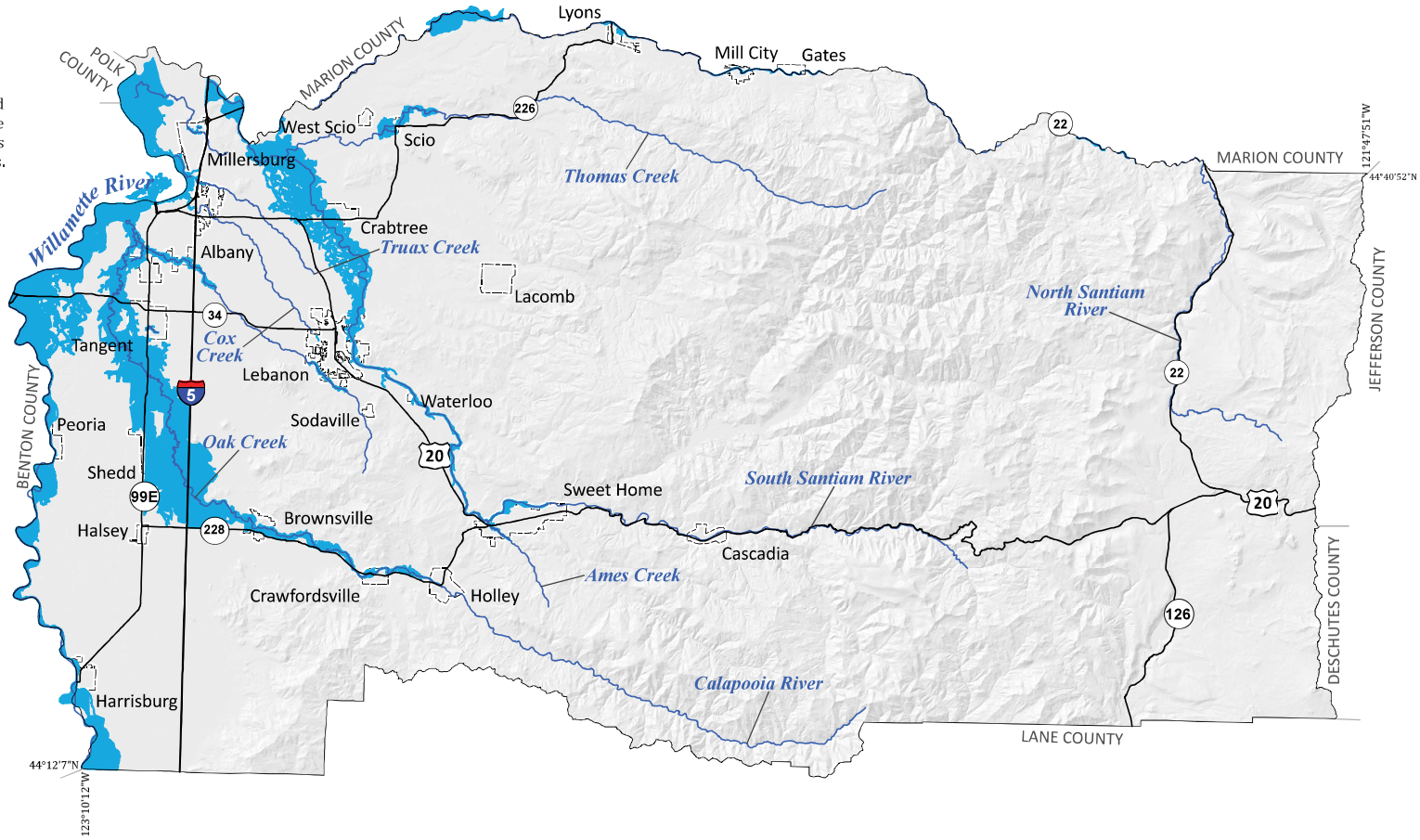
Flood Hazard Map of Linn County, Oregon

The flood hazard data show areas expected to be inundated during a 100-year flood event. Flooding sources include riverine. Areas are consistent with the regulatory flood zones depicted in Linn County's Digital Flood Insurance Rate Maps.





Data Sources:
Flood hazard zone (100-year): Linn County Flood Insurance Rate Map (2016)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

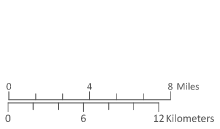
Cartography by: Matt C. Williams, 2024

Flood Hazard Zone

100-Year Flood
(1% annual chance)*

*Only 100-year scenario shown on map. Graph included shows 10-, 50-, 100-, 500-year results

Study Location Map



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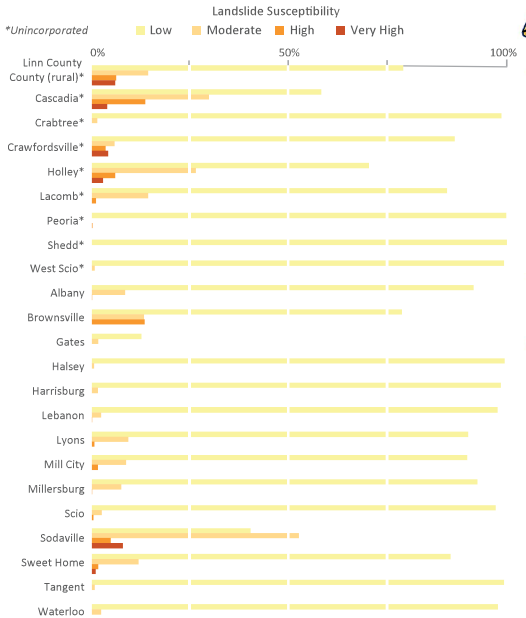
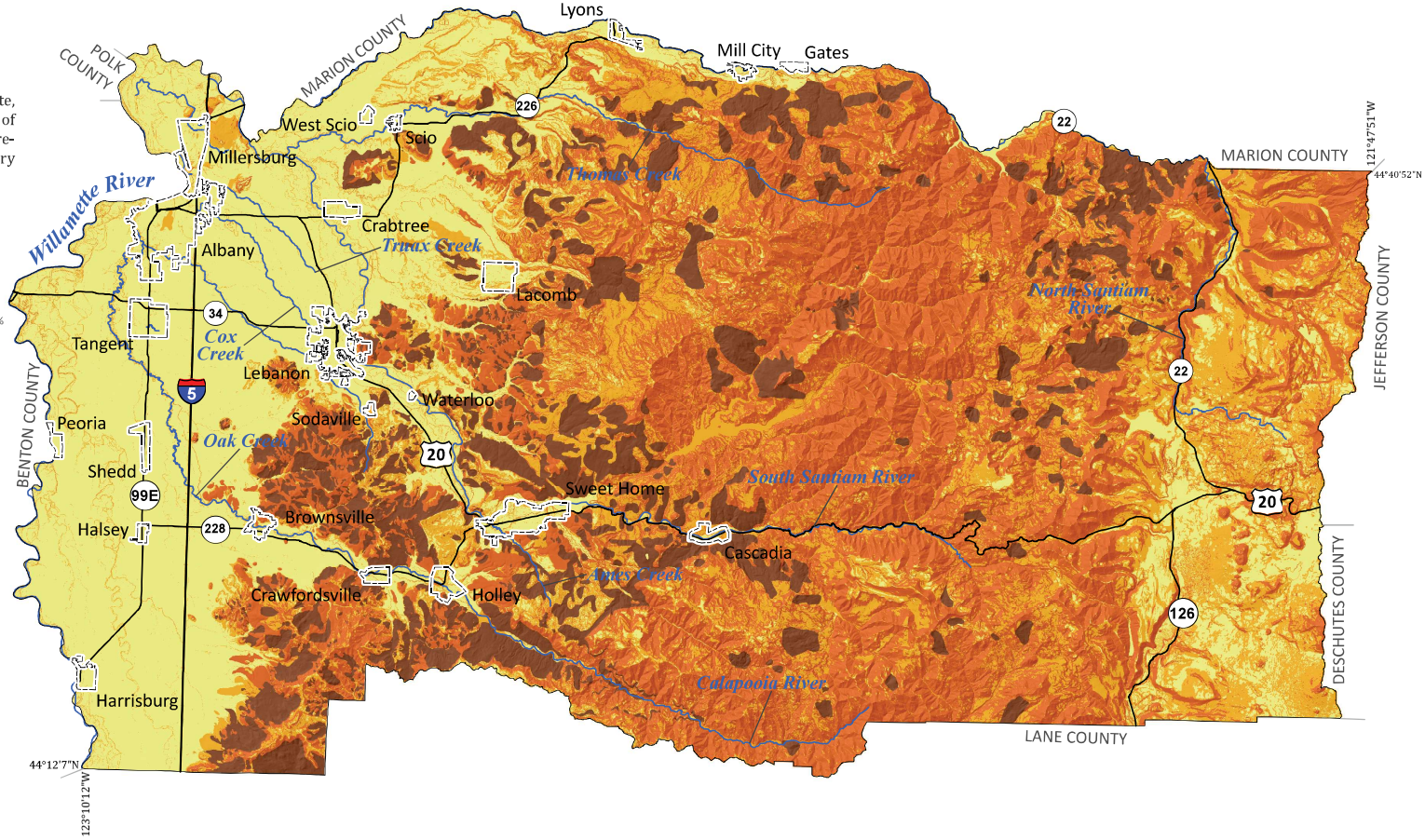
Landslide Susceptibility Map of Linn County, Oregon

Landslide susceptibility is categorized as Low, Moderate, High, and Very High which describes the general level of susceptibility to landslide hazard. The dataset is an aggregation of three primary sources: landslide inventory (SLIDO), generalized geology, and slope.





Data Sources:
Landslide susceptibility: Oregon Department of Geology and Mineral Industries, Burns and others (2016)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

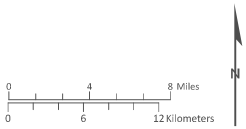
Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Cartography by: Matt C. Williams, 2023

Landslide Susceptibility

- Low
- Moderate
- High
- Very High

Study Location Map



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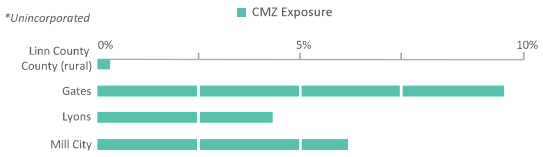
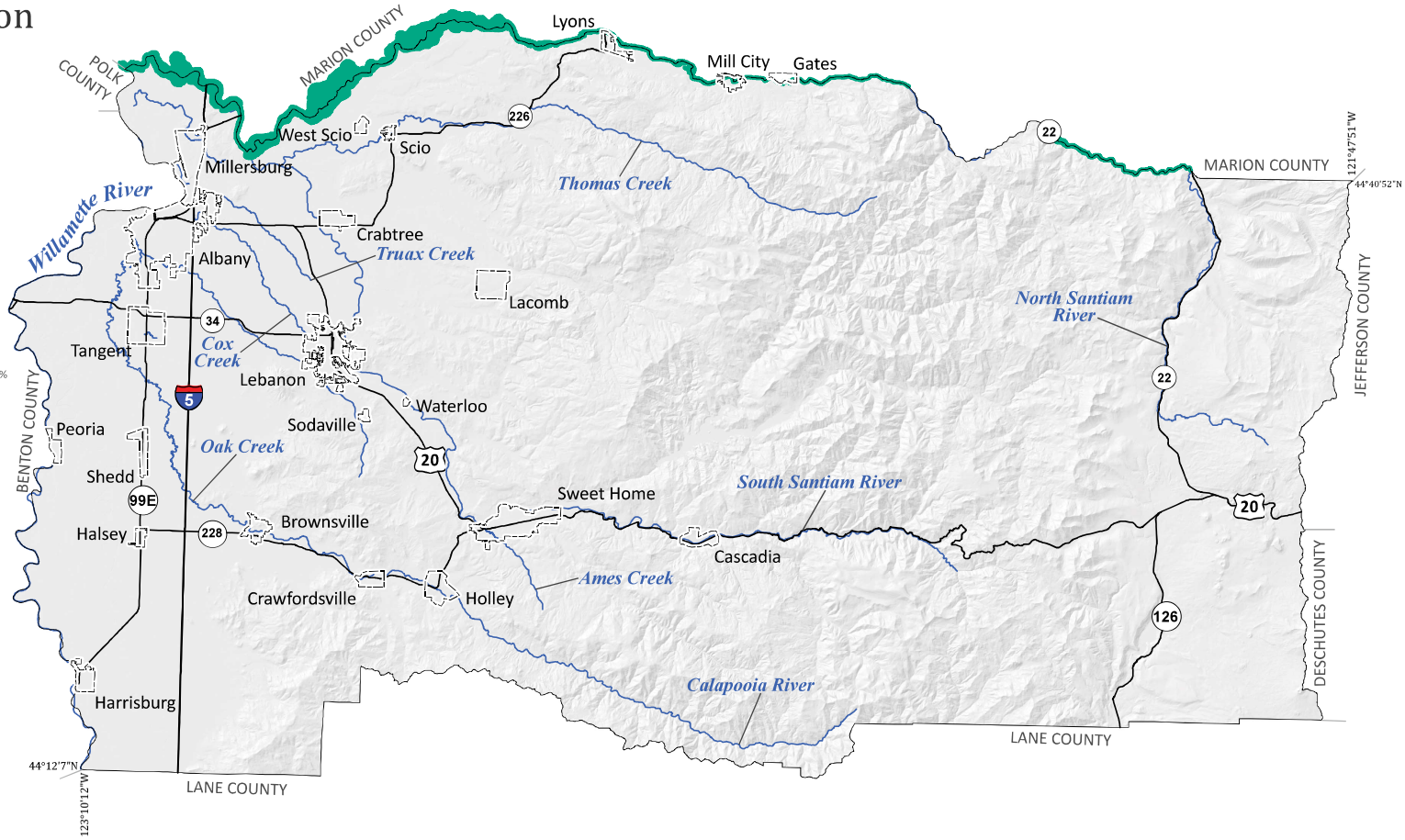
Channel Migration Hazard Map of Linn County, Oregon

Channel migration is a process by which a stream's course changes over time due to bank erosion and stream deposition. The channel migration zone is defined by the 30-year Erosion Hazard Area (EHA). Shown are the 30-year EHA in Linn County. Buildings within these areas are at greater risk to channel migration hazard than other areas.





Data Sources:
Channel migration zone (30-year): DOGAMI (Appleby and others, 2021)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Cartography by: Matt C. Williams, 2024

Channel Migration Hazard Zone

30-Year Erosion

Study Location Map

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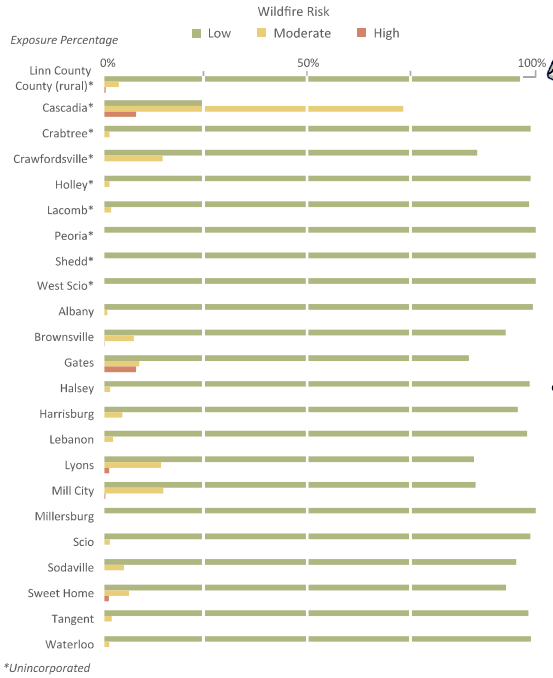
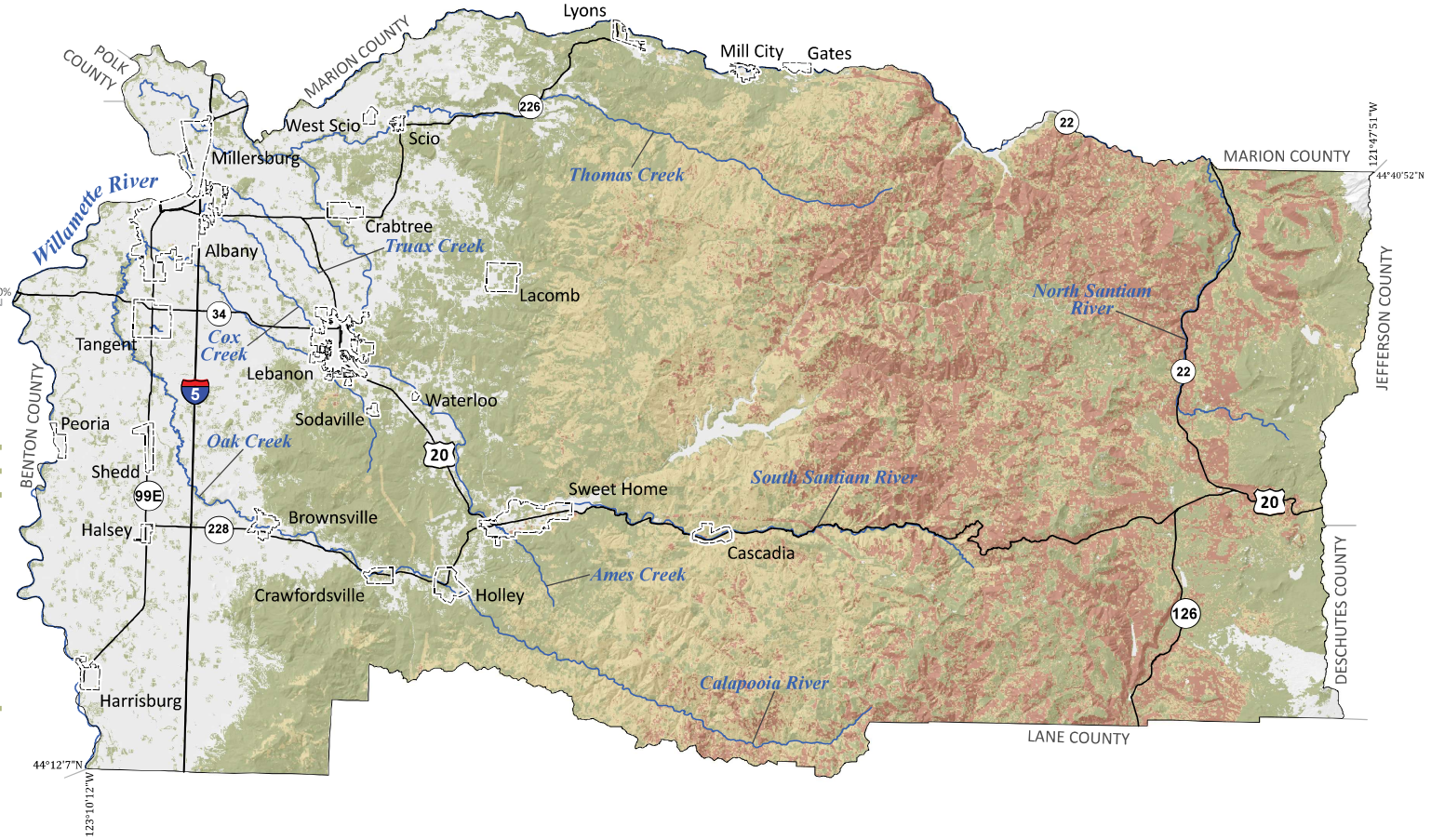
Wildfire Risk Map of Linn County, Oregon

Wildfire Risk is categorized as Low, Moderate, and High and indicates the level of risk a location has to wildfire hazard. The Wildfire Risk data layer is derived from a combination of the burn probability (fire history and behavior) and conditional flame length data.



*Unincorporated



Wildfire Risk

- Low
- Moderate
- High

Study Location Map

0 4 8 Miles
0 6 12 Kilometers

N

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Data Sources:
Wildfire risk data: Oregon Department of Forestry, Pyrologix, LCC. (2018)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

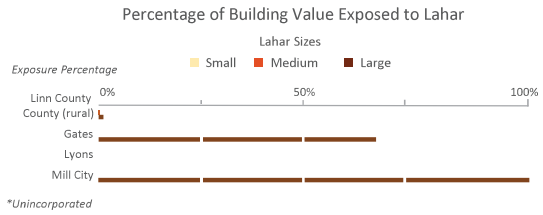
Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

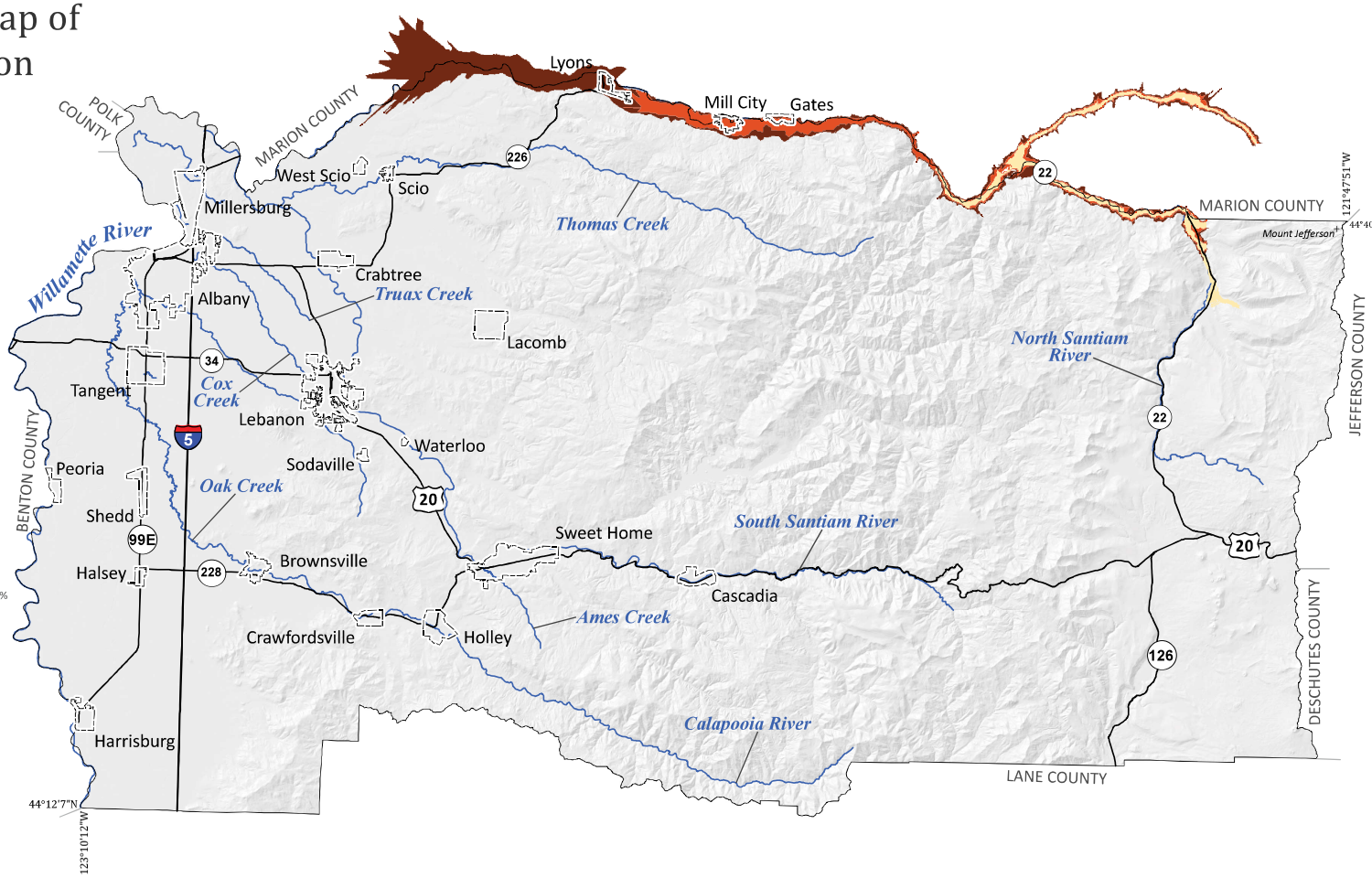
Cartography by: Matt C. Williams, 2024

PLATE 11

Lahar Exposure Map of Linn County, Oregon

The lahar hazard data show areas of expected exposure from several local lahar scenarios produced from a volcanic event on Mt. Jefferson. The scenarios were categorized based on three sizes, ranging from Small to Large.





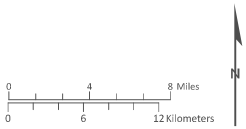
Data Sources:
Mount Jefferson lahar zones: USGS (Walder and others, 1999)
Roads: Oregon Department of Transportation Signed Routes (2013)
Place names: U.S. Geological Survey Geographic Names Information System (2015)
City limits: Oregon Department of Transportation (2014)
Basemap: Oregon Lidar Consortium (2014)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 UTM Zone 10N
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Cartography by:Matt C. Williams, 2024

Lahar Hazard Zone

- Small
- Medium
- Large



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APPENDIX F:
OCCRI FUTURE CLIMATE PROJECTIONS, LINN COUNTY, OREGON

Future Climate Projections
Linn County, Oregon

Updated September 2023

Oregon Climate Change Research Institute

Future Climate Projections: Linn County, Oregon

Meghan Dalton, Erica Fleishman, Dominique Bachelet, and David Rupp
Oregon Climate Change Research Institute
College of Earth, Ocean, and Atmospheric Sciences
104 CEOAS Administration Building
Oregon State University
Corvallis, OR 97331

September 2023

Cover photograph: Crabtree Creek, Linn County, Oregon by Rick Obst, CC BY 2.0, via flickr.com

Table of Contents

Executive Summary 4
Introduction 8
Future Climate Projections Background 10
Average Temperature 18
Heat Waves 20
Cold Waves 32
Heavy Precipitation 38
River Flooding 46
Drought 56
Wildfire 59
Reduced Air Quality 66
Loss of Wetlands 70
Windstorms 72
Expansion of Non-native Invasive Species 74
Appendix 80
References 83

Executive Summary

Climate change is expected to increase the occurrence of many climate-related natural hazards and to increase climate-related risks to assets, such as people, buildings, and infrastructure. Confidence that the risk of heat waves will increase is very high (Table 1) given strong evidence in the peer-reviewed literature, consistency among the projections of different global climate models, and robust scientific principles that explain why temperatures increase in response to ongoing emissions of greenhouse gases. In areas where the human population is growing, and especially where it is aging, both the absolute number and the proportion of people at risk from heat exposure is increasing. Confidence that the risk of many other natural hazards will increase as climate changes is high or medium (Table 1), reflecting moderate to strong evidence in the peer-reviewed literature and consistency among models. The latter risks are influenced by multiple factors in addition to increasing temperatures. Confidence that the risk of windstorms will change is low given that projections suggest relatively few to no changes and evidence is limited.

Table 1. Projected direction and level of confidence in changes in the risks of climate-related natural hazards and associated risks to assets. Very high confidence means that the direction of change is consistent among nearly all global climate models and there is robust evidence in the peer-reviewed literature. High confidence means that the direction of change is consistent among more than half of models and there is moderate to robust evidence in the peer-reviewed literature. Medium confidence means that the direction of change is consistent among more than half of models and there is moderate evidence in the peer-reviewed literature. Low confidence means that the direction of change is small compared to the range of model responses or there is limited evidence in the peer-reviewed literature.

	Low Confidence	Medium Confidence	High Confidence	Very High Confidence
↑ Risk Increasing		Drought Expansion of Non-native Invasive Species Reduced Air Quality Loss of Wetlands	Heavy Precipitation Flooding Wildfire	Heat Waves
= Risk Unchanging	Windstorms			
↓ Risk Decreasing				Cold Waves

In this report, we present climate projections for Linn County of natural hazards for the 2020s (2010–2039) and 2050s (2040–2069) relative to the 1971–2000 historical baseline and, where possible, we compare projections to observations. The projections are based on multiple global climate models for both a lower greenhouse gas emissions scenario (RCP 4.5) and a higher emissions scenario (RCP 8.5). Unless otherwise noted, all projections in this executive summary refer to the 2050s, relative to the historical baseline, under the higher emissions scenario. Projections for both time periods and emissions scenarios, and potential consequences for assets given current demographic data and projected population trends, are included in the main report.

Heat Waves

The number, duration, and intensity of extreme heat events will increase as temperatures continue to warm. In Linn County, the number of extremely hot days (those on which the temperature is 90°F or higher) and the temperature on the hottest day of the year are projected to increase by the 2020s and 2050s under both the lower and higher emissions scenarios. The number of days per year with temperatures 90°F or higher is projected to increase by an average of 17 (range 5–29) by the 2050s under the higher emissions scenario. The temperature on the hottest day of the year is projected to increase by an average of about 7°F (range 2–10°F) by the 2050s. Projected demographic changes, such as an increase in the proportion of older adults, will increase the number of people in some of the populations that are at greatest risk from extreme heat.

Cold Waves

Cold extremes will become less frequent and intense as the climate warms. The number of cold days (maximum temperature 32°F or lower) per year in Linn County is projected to decrease by an average of 4 (range 2–5). The temperature on the coldest night of the year is projected to increase by an average of 6°F (range 1–11°F). The number of county residents at greatest risk from extreme cold is likely to grow, although this increase may be offset somewhat by the decrease in incidence of cold extremes.

Heavy Precipitation

The intensity of extreme precipitation is expected to increase as the atmosphere warms and holds more water vapor. In Linn County, the number of days per year with at least 0.75 inches of precipitation is not projected to change substantially. Nevertheless, the amount of precipitation on the wettest day and wettest consecutive five days per year is projected to increase by an average of 14% (range -1–35%) and 10% (range -1–22%), respectively. The number of days per year that exceed a threshold for landslide risk that is based on prior 18-day precipitation accumulation is not projected to change substantially. However, landslide risk depends on multiple factors, and this metric does not reflect all aspects of the hazard.

River Flooding

Winter flood risk at intermediate to low elevations in Linn County, where temperatures are near freezing during winter and precipitation is a mix of rain and snow, is projected to increase as winter temperatures increase. The temperature increase will lead to an increase in the percentage of precipitation falling as rain rather than snow.

Drought

Drought, as represented by low spring snowpack, low summer precipitation, low summer soil moisture, and low summer runoff, is projected to become more frequent in Linn County. The incidence of related negative physical and mental health outcomes, especially among low income, tribal, rural, and agricultural communities, is likely to increase.

Wildfire

Wildfire frequency and area burned are projected to continue increasing in the Northwest, and wildfire intensity is projected to increase. Wildfire risk, expressed as the average number of days per year on which fire danger is very high, is projected to increase in Linn County by 12 days (range -6–31). The average number of days per year on which vapor pressure deficit is extreme is projected to increase by 28 (range 10–43).

Reduced Air Quality

Climate change is expected to reduce outdoor air quality. The risks to human health from wildfire smoke in Linn County are projected to increase. From 2004–2009 to 2046–2051, under a moderate emissions scenario, the number of days per year with poor air quality due to elevated concentrations of wildfire-derived fine particulate matter is projected to increase by 13%. The concentration of fine particulate matter on those days is projected to increase by 88%.

Loss of Wetlands

In Linn County, losses of wetlands in recent decades largely were caused by conversion to agriculture. Projected effects of climate change on wetlands in the Northwest include reductions in water levels and hydroperiod duration. If withdrawals of ground water do not increase, wetlands that are fed by ground water rather than surface water may be more resilient to climate change.

Windstorms

Wind patterns affect provision of electricity, transportation safety, fire ignition, and the spread of wildfires and pollutants. Mean wind speeds in Oregon are projected to decrease slightly, but extreme winter wind speeds may increase, especially in western Oregon. The frequency of strong easterly winds during summer and fall, however, is projected to decrease slightly.

Expansion of Non-native Invasive Species

In general, non-native invasive plants in Linn County are likely to become more prevalent in response to projected increases in temperature and the frequency, duration, and severity of drought. However, many of these responses are uncertain, are likely to vary locally, and may change over time.

Introduction

Industrialization has increased the amount of greenhouse gases emitted worldwide, which is causing Earth's atmosphere, oceans, and lands to warm (IPCC, 2021). Climate change and its effects already are apparent in Oregon (Dalton *et al.*, 2017; Mote *et al.*, 2019; Dalton and Fleishman, 2021; Fleishman, 2023). Climate change is expected to increase the likelihood of natural hazards such as heat waves, heavy precipitation, flooding of rivers and streams, drought, wildfires, and poor air quality, and to decrease the likelihood of cold waves.

We analyzed the influence of climate change on natural hazards in Linn County, Oregon, and explored potential effects of those natural hazards on the county's assets. Products of our analysis include county-specific data, graphics, and narrative summaries of climate trends and projections related to ten climate-related natural hazards (Table 2). This information will be integrated into the county's Natural Hazards Mitigation Plan and can be used in other county plans, policies, and programs.

Table 2. Selected natural hazards and related climate metrics.

Heat Waves Hottest Day, Warmest Night Hot Days, Warm Nights	**Cold Waves** Coldest Day, Coldest Night Cold Days, Cold Nights
Heavy Precipitation Wettest Day, Wettest Five Days Wet Days, Landslide Risk Days	**River Flooding** Annual Maximum Daily Flows Atmospheric Rivers Rain-on-Snow Events
Drought Summer Flow, Spring Snow Summer Soil Moisture Summer Precipitation	**Wildfire** Fire Danger Days Extremely Dry Air Days
Reduced Air Quality Days with Unhealthy Smoke Levels	**Loss of Wetlands**
Windstorms	**Expansion of Non-native Invasive Species**

In 2020, an estimated 127,320 people lived in Linn County (PRC, 2023a). The county's population is projected to increase by 15% by 2040, and by another 14% (or 30% relative to 2020) by 2069 (PRC, 2023b). Social factors affect the probability that natural hazards will negatively affect individuals and communities. For example, inequities in housing, education, income, and transportation access affect how different populations respond to heat, drought, and other extremes (Ho *et al.*, 2021). The U.S. Centers for Disease Control and Prevention developed and maintains a social vulnerability index for use in planning and response to hazardous events (Flanagan *et al.*, 2011; ATSDR, 2022). The index encompasses 16 variables, which are aggregated into four themes: socioeconomic status,

household characteristics, racial and ethnic minority status, and housing type and transportation (Table 3). Higher values indicate higher vulnerability (ATSDR, 2022).

Table 3. Measures of social vulnerability in Linn County, Oregon, as estimated on the basis of the 2016–2020 American Community Survey (ATSDR, 2022). Housing cost burden is defined as an occupied housing unit with a household annual income below $75,000 and monthly housing costs that equal or exceed 30 percent of annual income. Single-parent households include one or more children under the age of 18. Racial and ethnic minority status includes individuals who identify as Hispanic, Latino (of any race), Black, African American, American Indian, Alaska Native, Asian, Native Hawaiian, Pacific Islander, two or more races, and other non-White races. Multi-unit housing refers to housing structures with ten or more units. Crowded housing is defined as an occupied housing unit with more people than rooms. Number of households without a broadband internet subscription is not included in calculation of the overall social vulnerability index. CI, confidence interval. Percentage, percentage of population or number. Percentages for some variables do not correspond exactly to raw values.

Social vulnerability metric	Population or number	CI	Percentage	CI
Total population	127,216			
Number of housing units	50,936	50,792–51,080		
Number of households	48,290	47,813–48,767		
Socioeconomic status				
Below 150% poverty	28,232	26,386–30,078	22.6	21.1–24.1
Unemployed	4116	3462–4770	6.8	5.7–7.9
Number of cost-burdened housing units	14,834	13,948–15,720	30.7	28.9–32.5
No high school diploma	8995	8055–9935	10.1	9.0–11.2
No health insurance	9357	7844–10,870	7.4	6.2–8.6
Household characteristics				
Aged 65 or older	23,643	23,584–23,702	18.6	18.5–18.7
Aged 17 or younger	28,581	28,533–28,629	22.5	
Civilian with a disability	21,807	20,651–22,963	17.2	16.3–18.1
Single-parent household	2568	2121–3015	5.3	4.4–6.2
Speaks English less than well	1595	1261–1929	1.3	1.0–1.6
Racial and ethnic minority status				
Minority	19,913	18,836–20,990	15.7	14.9–16.5
Housing type and transportation				
Number of multiple-unit homes	3435	3018–3852	6.7	5.9–7.5
Number of mobile homes	6681	6077–7285	13.1	11.9–14.3
Number of crowded housing units	1440	1116–1764	3.0	2.3–3.7
Number of households with no vehicle	2266	1891–2641	4.7	3.9–5.5
People in group quarters	1435	1067–1803	1.1	0.8–1.4
People in households without a broadband internet subscription	13,743	12,171–15,315	10.9	

Future Climate Projections Background

Introduction

The county-specific future climate projections presented here are derived from 10–20 global climate models and two scenarios of future global emissions of greenhouse gases. The spatial resolution of projections from global climate models has been increased through downscaling to better represent local conditions. County-level summaries of changes in climate metrics (Table 2) are projected to the beginning and middle of the twenty-first century relative to a historical baseline. We compared the simulated historical baseline and projections for the beginning of the twenty-first century with observations. More information about the modeled and observed data sources is in the appendix.

Global Climate Models

Global climate models are computer models of Earth's atmosphere, ocean, and land and their interactions over time and space. Climate models generally refer to both general circulation models (GCMs) and Earth system models (ESMs). GCMs simulate the interactions between the atmosphere and the land and ocean, whereas ESMs also simulate more-detailed chemical and biological processes that interact with the physical climate. Global climate models are grounded in the fundamental laws of physics and are the most sophisticated tools for understanding Earth's climate. However, they still necessarily simplify the climate system. Because there are several ways to simplify climate in a global model, different climate models yield somewhat different projections. Accordingly, the scientific community usually examines projections from multiple global climate models.

Over time, the spatial resolution of GCMs has increased and more physical, chemical, and biological processes, such as wildfire emissions and vegetation change, have been included (Figure 1). The climate models from the sixth phase of the Coupled Model Intercomparison Project (CMIP6), the climate modeling foundation of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), generally have higher resolution, better represent Earth system processes, and improve simulation of recent mean values of climate change indicators relative to climate models from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) (IPCC, 2021). However, some CMIP6 models overestimate observed temperatures in the twentieth century, likely because they simulated a greater increase in temperature in response to modeled changes in cloud patterns (Dalton *et al.*, 2021; IPCC, 2021). Consequently, the IPCC ranked climate models on the basis of their ability to reproduce twentieth-century temperatures, and used only the most accurate models to project warming given different scenarios of greenhouse gas emissions (Hausfather *et al.*, 2022).

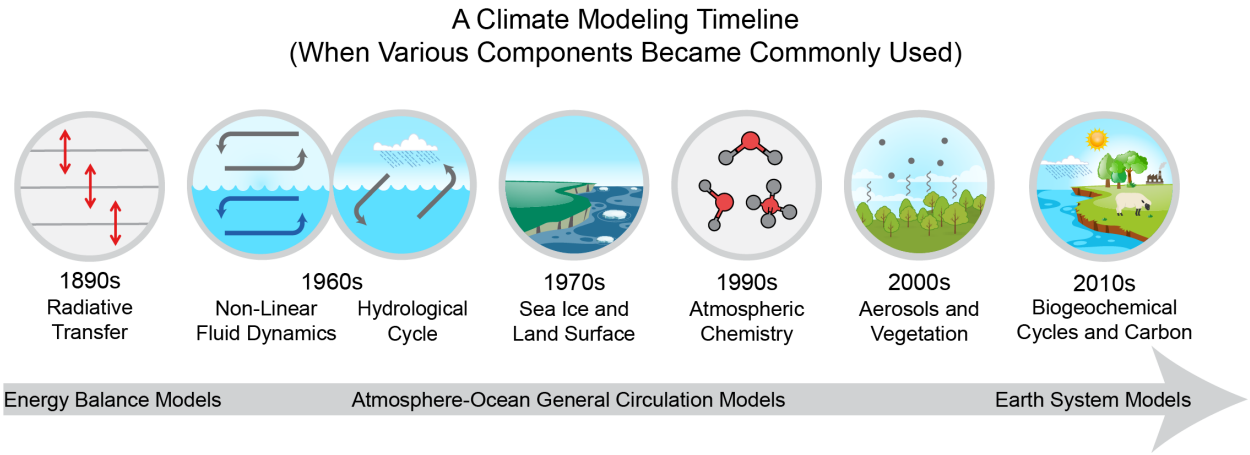

Figure 1. As scientific understanding of climate has evolved over the last 120 years, increasing amounts of physics, chemistry, and biology have been incorporated into global climate calculations. Over the second half of the twentieth century, as computing resources became available, such knowledge also was incorporated into global climate models. (Source: science2017.globalchange.gov)

Differences in simulations of Oregon's projected average temperature between the CMIP5 and CMIP6 models were estimated in the fifth Oregon Climate Assessment (Dalton *et al.*, 2021). The group of CMIP6 models generally projected greater warming over Oregon than the group of CMIP5 models. This outcome was due to the inclusion of several of the CMIP6 models that produce greater warming than most models given the same concentration of greenhouse gases.

One measure of climate sensitivity, the equilibrium climate sensitivity (ECS), is an estimate of the increase in global temperature after it stabilizes over hundreds to thousands of years following a doubling of carbon dioxide concentrations from pre-industrial levels. On the basis of observations, paleoclimate data, and other evidence, the ECS of Earth was estimated to be within 4.5–7.2°F (66% likelihood) or 3.6–9.0°F (90% likelihood) (Forster *et al.*, 2021). The scientific community typically evaluates climate model outputs on the basis of how close they are to this range of ECS. ECS in all CMIP5 models was less than 9°F, whereas about one-fifth of the CMIP6 models had an ECS above 9°F (Hausfather *et al.*, 2022). Although there is a 5% likelihood that Earth's ECS is above 9°F, the CMIP6 climate models with ECS >9°F overestimate the observed warming and therefore are considered less valid and reliable than those with ECS ≤9°F. Consequently, use of the average and range of the CMIP6 model ensemble likely will yield inaccurate projections of future climate (Hausfather *et al.*, 2022).

It is best practice to analyze and present an average and range of projections from at least ten global climate models with realistic climate sensitivity that simulate the historical climate well (Mote *et al.*, 2011; Hausfather *et al.*, 2022; Dalton and Bachelet, 2023). In this report, we rely on projections from 10–20 CMIP5 models (see *Appendix*), all of which have realistic climate sensitivities and are still considered valid and useful in evaluating future climate (Dalton and Bachelet, 2023). Additionally, locally relevant, high-resolution projections from the CMIP5 models are readily available. As a group, the 20 CMIP5 models

used in this report generally simulate the historical climate of the Pacific Northwest well (Rupp *et al.*, 2013). The ability of individual models to simulate the historical period varies. Half of the 20 CMIP5 models used in this report rank within the top half of the 41 climate models evaluated over the Pacific Northwest (Rupp *et al.*, 2013). The relative ranks of the 20 CMIP5 models are included in the appendix (Table A1).

It will be advantageous to consider CMIP6 climate projections after the scientific community has further evaluated the projections and associated impacts and high-resolution projections are vetted for geographic regions with different characteristic climates (Dalton and Bachelet, 2023). An evaluation for the Pacific Northwest is pending and is expected to be available by late 2024.

Greenhouse Gas Emissions

Gases that contribute to climate change. The major gases in the atmosphere that contribute to climate change are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (EPA, 2023). These gases absorb energy radiated by Earth's sun-heated surface, then redirect a portion of that energy back to the surface, causing further warming. Water vapor traps heat in the same manner. CO_2, CH_4, N_2O, and water vapor exist naturally in the atmosphere and are essential for maintaining Earth's temperature within a range that is habitable by living organisms. This is called the greenhouse effect. Human activities are increasing the quantities of CO_2, CH_4, N_2O, and fluorinated gases in the atmosphere, enhancing the greenhouse effect by trapping additional energy (heat). As concentrations of CO_2, CH_4, N_2O, and fluorinated gases increase, the oceans warm and more water evaporates into the atmosphere, exacerbating increases in temperature that are caused by emissions of the former gases.

Carbon dioxide (CO_2) in the atmosphere is produced by natural processes, such as plant respiration and volcanic eruptions, and by human activities. Increases in atmospheric concentrations of CO_2 account for about 65% of climate change since 1750 (Table 4) (Forster *et al.*, 2021). Nearly all of those increases result from human activities, especially consumption of coal, gasoline, and other fossil fuels (Lindsey, 2022). CO_2 also is released to the atmosphere during production of cement (Andrew, 2019) and when forests are harvested for timber or burned and converted to agricultural, industrial, or residential uses.

Ice cores document that for at least 400,000 years before present, the atmospheric concentration of CO_2 ranged from about 180 to 280 parts per million (ppm) (Bauska, 2022). During the late 1700s, as the Industrial Revolution began, CO_2 concentrations were about 280 ppm. By 2000, the concentration approached 370 ppm. As of 2022, the concentration was 417 ppm (Table 4). Therefore, the rate at which human activities are adding CO_2 to the atmosphere is increasing. Current concentrations of CO_2 are similar to those during the mid-Pliocene, more than 4 million years ago. At that time, the average global temperature was 7˚F higher than during the mid 1700s and sea levels were about 75 feet higher than today. Because CO_2 in the atmosphere persists for 300–1000 years (Buis, 2019), the process and effects of climate change cannot be reversed quickly, even if human behavior and emissions change rapidly.

Table 4. Current values, trends, and other metrics of atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) and percentage of global emissions and contributions to climate change. ppm, parts per million; ppb, parts per billion. Total anthropogenic greenhouse gas emissions in 2019 were 59 gigatonnes of CO_2-equivalent.

Metric	**CO_2**	**CH_4**	**N_2O**
Atmospheric concentration, 2022 (NOAA, 2023)	417 ppm	1912 ppb	336 ppb
Percentage increase, 1750–2019 (Forster *et al.*, 2021; Gulev *et al.*, 2021)	47	156	23
Global warming potential over 100 years, relative to CO_2 (Smith *et al.*, 2021)	1	28	273
Atmospheric lifetime (years) (Smith *et al.*, 2021)	300–1000 (Buis, 2019)	12	109
Percentage of net global sources of each gas that was produced by human activities during the years noted (Canadell *et al.*, 2021)	100 (2010–2019)	51–65 (2008–2017)	43 (2007–2016)
Percentage of total anthropogenic greenhouse gas emissions, 2019 (Dhakal *et al.*, 2022)	75 (64 fossil fuel combustion and industrial processes; 11 land use, land use change, and forestry)	19	5
Contribution to climate change (percentage of total effective radiative forcing, 1750–2019) (Forster *et al.*, 2021)	65	16	6

Net emissions of methane (CH_4), of which 51–65% are produced by human activity (Canadell *et al.*, 2021), account for about 16% of climate change since the Industrial Revolution (Table 4) (Forster *et al.*, 2021). The primary natural cause of CH_4 emissions is decomposition of plants in wetlands (EPA, 2023). Among human sources of CH_4, agriculture is the greatest contributor, followed closely by use of fossil fuels (IEA, 2023). Rice farming and digestion and excretion by livestock generate considerable volumes of CH_4. Production and transportation of oil, gas, coal, and bioenergy produce almost as much

CH_4 as agriculture. Decomposition of materials in landfills, biomass burning, and other sources also emit CH_4.

The atmospheric concentration of CH_4 has increased by more than 150% since the start of the Industrial Revolution (Table 4). The concentration of CH_4 in the atmosphere is much lower than that of CO_2—currently more than 1900 parts per billion (1.9 ppm) (Table 4) (Gulev *et al.*, 2021). However, each molecule of CH_4 traps about 28 times more heat than each molecule of CO_2 over 100 years. CH_4 in the atmosphere persists for about 12 years (Smith *et al.*, 2021).

Forty-three percent of net global sources of nitrous oxide (N_2O) is produced by human activity (Canadell *et al.*, 2021), primarily production and use of nitrate in conventional and organic agricultural fertilizers (Tian *et al.*, 2020). N_2O also is produced by burning of fossil fuels and vegetation. Atmospheric concentrations of N_2O increased by 23% from 1750–2019 (Gulev *et al.*, 2021), and accounted for about 6% of climate change during that period (Table 4) (Forster *et al.*, 2021). A molecule of N_2O persists in the atmosphere for about 109 years and, over 100 years, traps about 273 times more heat than a molecule of CO_2 (Table 4) (Smith *et al.*, 2021).

Nearly all fluorinated gases are produced by humans. The major classes of fluorinated gases are hydrofluorocarbons, perfluorocarbons, sulfur hexafluorine (SF_6), and nitrogen trifluorine (NF_3). Among fluorinated gases, hydrofluorocarbons are the greatest contributors to climate change. Hydrofluorocarbons are used as refrigerants, solvents, fire retardants, and to propel aerosols and foam (EPA, 2023). A molecule of most hydrofluorocarbons can trap hundreds to thousands of times more heat than a molecule of CO_2 over 100 years, and some hydrofluorocarbons persist in the atmosphere for up to 228 years (Smith *et al.*, 2021). Substitutions that will not contribute to climate change are being developed.

Perfluorocarbons are generated during aluminum production and are necessary for manufacture of semiconductors (EPA, 2023). They can persist in the atmosphere for thousands to tens of thousands of years, and some trap as much as 12,400 times more heat per molecule than CO_2 (Smith *et al.*, 2021). SF_6 and NF_3 also are used to manufacture semiconductors. In addition, SF_6 is used in magnesium production, to trace gas leaks, and to insulate electricity transmission systems (EPA, 2023). SF_6 persists for about 1000 years and traps 24,300 times more heat per molecule than CO_2 over 100 years. NF_3 persists for about 569 years and traps about 17,400 times more heat per molecule than CO_2 over 100 years (Smith *et al.*, 2021).

Climate models and emissions scenarios. When scientists use global climate models to project climate, they make assumptions about the future volume of global emissions of greenhouse gases. The models simulate the effects of those emissions on the atmosphere, oceans, and land over the coming centuries. Because the precise amount of greenhouse gases that will be emitted in the future is unknown, scientists use multiple scenarios of greenhouse gas emissions that correspond to plausible societal trajectories.

The CMIP5 models used scenarios called Representative Concentration Pathways (RCPs), which describe concentrations of greenhouse gases, aerosols, and other factors through the year 2100. These concentrations affect the level of outgoing long-wave radiation from Earth's surface, thus the radiative forcing. Radiative forcing is the total amount of energy retained in the atmosphere after absorption of incoming solar radiation, which is affected by the reflectivity of Earth's surface, and emission of outgoing long-wave radiation. The higher the volume of global emissions, the greater the radiative forcing and projected increase in global temperature (Figure 2).

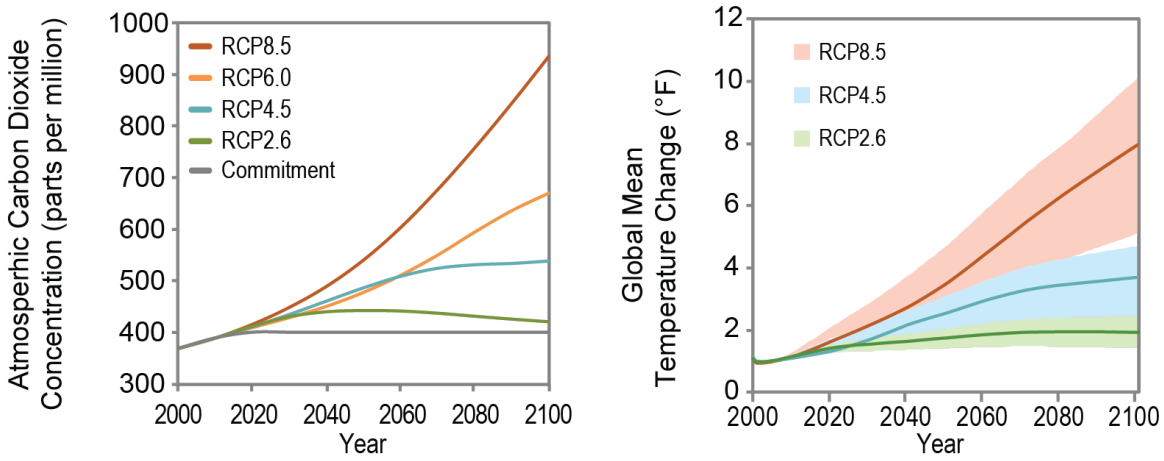

Figure 2. Future scenarios of atmospheric carbon dioxide concentrations (left) and projections of global temperature change (right) resulting from several different emissions scenarios, called Representative Concentration Pathways (RCPs), that were considered in the fourth National Climate Assessment (Hayhoe *et al.*, 2017). In the left plot, the gray line represents a scenario in which atmospheric carbon dioxide concentrations remain constant upon reaching 400 parts per million; this concentration was exceeded in 2013 and continues to increase. In the right plot, the solid line and shading represent the mean and range of simulations from global climate models included in CMIP5. (Source: science2017.globalchange.gov/chapter/4)

CMIP6 models used scenarios called Shared Socio-economic Pathways (SSPs). The SSPs reflect assumptions about future population, technological, and economic growth that were paired with the different levels of emissions associated with the CMIP5 RCPs (IPCC, 2021). Projections in this report are based on both a lower emissions pathway (RCP 4.5) and a higher emissions pathway (RCP 8.5) that are often described as representing moderate reductions and business-as-usual increases in greenhouse gas emissions, respectively (Hayhoe *et al.*, 2017). These two RCPs are the most common scenarios in the peer-reviewed literature, and high-resolution data representing the effects of these scenarios on local climate are available. As of 2020, emissions represented by RCP 8.5 were within 1% of cumulative historical emissions of carbon dioxide, and RCP 8.5 was considered to be the most realistic scenario for assessment of effects of climate change by 2050 (Schwalm *et al.*, 2020).

Downscaling

Global climate models simulate the climate across large, contiguous grid cells. One to three grid cells cover the state of Oregon. To make these coarse-resolution simulations more locally relevant, outputs are combined statistically with gridded historical observations (climate.northwestknowledge.net/MACA/MACAtrainingdata.php) from the NASA North American Land Data Assimilation System and Parameter-elevation Regressions on Independent Slopes Model, yielding higher-resolution projections. This process is called statistical downscaling. The resulting data compared well with other data from weather-observation stations. The future climate projections in this report were statistically downscaled to a resolution of about 2.5 by 2.5 miles (Abatzoglou and Brown, 2012). More information about downscaling is in the appendix.

Time Periods

When analyzing global climate model projections, it is best practice to compare the average of simulations across at least 30 future years to the average of simulations across at least 30 recent past years. The average over those 30 past years is called the *historical baseline*. We present projections averaged over two future 30-year periods, 2010–2039 (2020s) and 2040–2069 (2050s), relative to the historical baseline of 1971–2000. The 2020s projections reflect changes that have occurred or will occur in the coming decade. Projections for the 2050s reflect conditions a few decades into the future that potentially can be addressed by current planning efforts. In addition, we compare observations to simulations for the periods 1971–2000 and 2010–2022. In some cases, the observational data do not cover the entire simulated historical baseline period, in which case we compare the first year for which data were available (1979) through 2005 (the final year of model simulations of historical climate) to the simulated historical baseline.

Because each of the 20 CMIP5 models from which we obtained projections is based on slightly different assumptions, each yields a slightly different value for the simulated historical baseline. Therefore, we do not present the average and range of projected absolute values of variables. Instead, we present the average and range of projected changes in values of climate variables relative to each model's historical baseline. We also present the average of the 20 historical baselines to aid in understanding the relative magnitude of projected changes. The average projected change can be added to the average historical baseline to infer the average future value of a given variable. The average projected change and historical baseline are included in the tables.

How to Use the Information in this Report

Because the observational record may not include plausible future values of some climate variables or the plausible future frequency of some extreme events, such as the June 2021 heat wave, one cannot reliably anticipate future climate by considering only past climate. Future projections from GCMs enable exploration of a range of plausible outcomes given the climate system's complex response to increasing atmospheric concentrations of greenhouse gases. Projections from GCMs should not be interpreted as predictions of the weather on a given date, but rather as projections of climate, which is the long-term statistical aggregate of weather (Walsh *et al.*, 2014).

The projected direction and magnitude of change in values of climate variables in this report are best interpreted relative to the historical climate under which a particular system or asset evolved or was designed to operate. For this reason, considering the projected changes between historical and future periods allows one to envision how natural and human systems may respond to future climate conditions that are different from past conditions. In some cases, the projected change may be small enough for the existing system to accommodate. In other cases, the projected change may be large enough to require adjustments, or adaptations, to the existing system. However, engineering or design projects would require an analysis that is more detailed than we present in this report.

The information in this report can be used to

- Explore a range of plausible future outcomes that reflect the climate system's complex response to increasing concentrations of greenhouse gases
- Envision how current systems may respond to climate conditions different from those under which the systems evolved or were designed to operate
- Inform evaluation of potential mitigation actions within hazard mitigation plans
- Inform assessment of the likelihood of occurrence of a particular climate-related hazard

Average Temperature

Oregon's annual average temperature warmed at a rate of 2.2°F per century from 1895 through 2021 (Fleishman, 2023). Average temperature is expected to continue increasing during the twenty-first century; the rate of warming depends on the level of emissions (IPCC, 2021). By the 2050s (2040–2069), relative to the 1970–1999 historical baseline, Oregon's average temperature is projected to increase by 3.6°F (range 1.8–5.4°F) under a lower emissions scenario (RCP 4.5) and by 5.0°F (range 2.9–6.9°F) under a higher emissions scenario (RCP 8.5) (Dalton *et al.*, 2017, 2021; Fleishman, 2023). Summers are projected to warm more than other seasons (Dalton *et al.*, 2017, 2021; Fleishman, 2023).

Annual average temperature in Linn County increased at a rate of 1.7°F per century from 1895 through 2022 (NCEI, 2023). The simulated average temperature over the 1971–2000 baseline period (49.3°F) is consistent with observations over the same time period (48.9°F). During the twenty-first century, average temperature in the county is projected to warm at a rate similar to that of Oregon as a whole (Figure 3). Projected increases in average temperature in the county, relative to the historical baseline in each global climate model (GCM), range from 0.8–3.2°F by the 2020s and 1.5–6.6°F by the 2050s, depending on the emissions scenario and GCM (Table 6).

Over the 13 years for which observations overlap the 2020s projections (2010–2022), the average temperature was projected to increase by 1.4°F, relative to the historical baseline, under the lower emissions scenario and by 1.6°F under the higher emissions scenario (Table 5). The observed change over these 13 years was 1.0°F, and observed total CO_2 emissions fell between the two emissions scenarios (Burgess *et al.*, 2020).

The apparent overestimation of Linn County's observed temperature trend by the climate models is consistent with the apparent discrepancy between modeled and observed global average temperatures over the first decade of the twenty-first century. Three factors may explain this discrepancy (Medhaug *et al.*, 2017). First, the timing of different magnitudes of annual and decadal natural variability projected in climate models is not expected to match observed natural variability. There is a 5% probability that modeled natural variability will dominate a global warming trend over a modeled 15-year period, but observed natural variability of a comparable magnitude is unlikely to occur during the same period of time (Medhaug *et al.*, 2017). Second, projected forcings included in the CMIP5 climate models may deviate from observed forcings. Forcings in the models to the year 2005 are based on observations, and the models simulate the historical period reasonably well. Projections from 2006 onward are based on assumptions of forcings that include greenhouse gases, aerosols, volcanic eruptions, and solar output. These assumed forcings may not coincide with actual forcings from 2006 onward, contributing to the difference between model-projected and observed temperature trends (Medhaug *et al.*, 2017). Third, methods for calculation of global mean temperature in models and observational data differ. Modeled global mean temperature is derived from surface air temperature over the land and oceans. Calculation of global mean temperature from observations is also based on surface air temperature over the land, but sea surface temperature rather than surface air temperature over the ocean (Medhaug *et al.*, 2017).

Table 5. Projected changes in annual temperature in Linn County between the 1971–2000 baseline period and future periods. Values are averages across 20 global climate models (range in parentheses). The 20-model mean and range of temperature averaged over the historical baseline period (1971–2000) was 49.3°F (48.8–49.6).

Emissions Scenario	Past		Future	
	Baseline (1971–2000 average)	Recent Past (2010–2022 average)	2020s (2010–2039 average)	2050s (2040–2069 average)
Observations	48.9°F	+1.0°F		
Lower (RCP 4.5)		+1.4°F (0.2–2.6)	+1.9°F (0.8–3.1)	+3.6°F (1.5–5.1)
Higher (RCP 8.5)		+1.6°F (0.7–2.4)	+2.2°F (1.2–3.2)	+4.8°F (2.5–6.6)

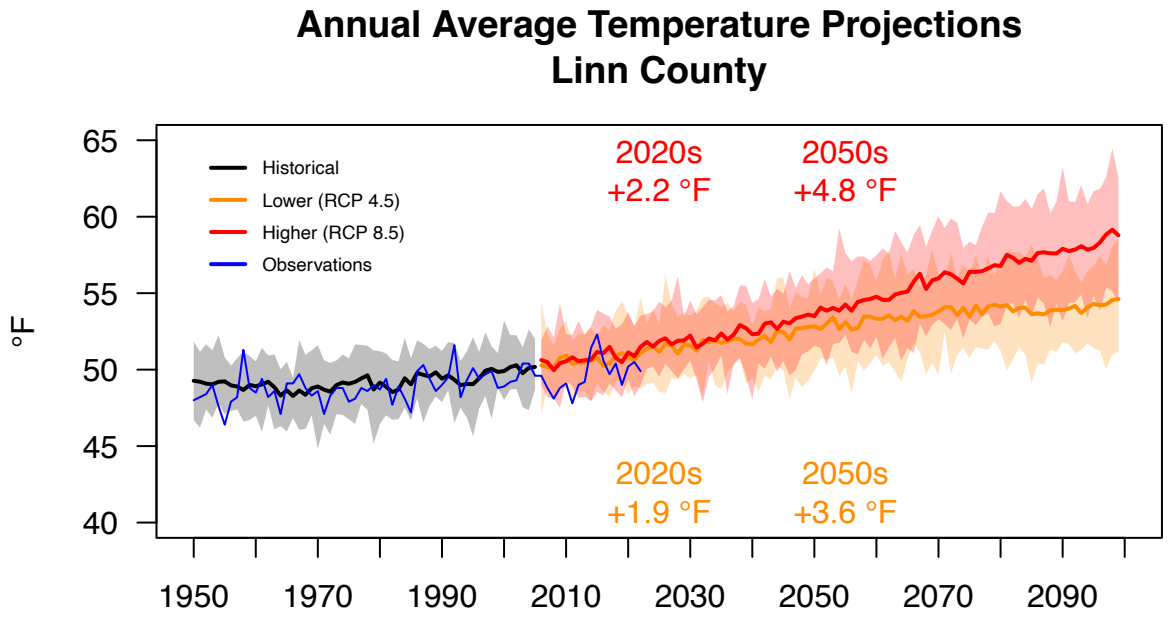

Figure 3. Projected annual average temperature in Linn County as simulated by 20 downscaled global climate models under a lower (RCP 4.5) and a higher (RCP 8.5) greenhouse gas emissions scenario. Solid lines and shading represent the 20-model mean and range, respectively. The figure shows the multiple-model mean differences between the historical baseline period (1971–2000) and the 2020s (2010–2039 average) and 2050s (2040–2069 average). Observations (blue line) are from the National Oceanic and Atmospheric Administration's National Centers for Environmental Information Climate at a Glance, www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/county/time-series.

Heat Waves

Heat is the leading cause of weather-related deaths in the United States (Khatana *et al.*, 2022), and the risk of heat-related mortality is increasing worldwide (Lüthi *et al.*, 2023). Extreme heat and home air conditioning are less common in Oregon than in many other parts of the country, leaving residents more vulnerable when extreme heat occurs. For example, record-breaking heat in June 2021 caused more than 100 deaths in Oregon, mostly inside homes without air conditioning (O'Neill *et al.*, 2023). Dangerous heat is almost always associated with a weather event called a heat wave: multiple consecutive days on which maximum or minimum temperatures are above a threshold or a probability (O'Neill *et al.*, 2023). Heat waves occur periodically as a result of natural variability in temperature, but human-caused climate change is increasing their frequency and intensity (Vose *et al.*, 2017; IPCC, 2021). In the absence of human-caused climate change, the intensity of the June 2021 heat wave would have been virtually impossible (Philip *et al.*, 2022). Additionally, the period over which heat waves occur is lengthening. For example, in Portland, Oregon, the duration of the heat wave season increased by 7 days per decade from 1961–2010 (Habeeb *et al.*, 2015). This trend is exemplified by the heat wave in May 2023, which broke several high-temperature records for the same date and month across the northwestern United States and Canada. High-pressure ridges caused both the June 2021 and May 2023 heat waves (earthobservatory.nasa.gov/images/151349/summer-temperatures-arrive-early).

Extreme heat can refer to extremely warm daytime highs or overnight lows (days on which maximum or minimum temperatures are above a threshold or a probability relative to past decades), seasons in which temperatures are well above average, and heat waves. In the Pacific Northwest, a day on which the maximum temperature is at least 90°F often is considered to be an extremely warm day. The number of such days increased significantly across Oregon since 1951 (O'Neill *et al.*, 2023). The heat index is a measure of perceived heat that reflects both temperature and relative humidity and is more relevant to human health than temperature alone. As relative humidity increases, a given temperature can feel hotter. The National Weather Service issues heat warnings when the heat index exceeds given local thresholds. Across Oregon, heat waves rarely are humid (Rastogi *et al.*, 2020), and the heat index generally is similar to the actual temperature. Nevertheless, the average number of hours per year in Oregon with a heat index of at least 90°F increased significantly since 1981 (O'Neill *et al.*, 2023).

The number of extremely warm nights is also increasing. In western Oregon, nights on which the minimum temperature was at least 65°F were rare before 1990, but the number of such nights has increased significantly in some areas during the past two decades (O'Neill *et al.*, 2023). In addition, evidence of increases in the number of summer extreme heat events that are defined by nighttime minimum temperatures is stronger than evidence of increases in the number of those defined by maximum temperatures (Dalton and Loikith, 2021).

The number, duration, and intensity of extreme heat events in Oregon is projected to increase due to continued increases in mean temperatures (Dalton and Loikith, 2021; O'Neill *et al.*, 2023). Climate models generally agree that changes in temperature extremes

largely are linearly correlated with changes in the mean temperature. However, some mechanisms, which are the subject of active research, might cause a more substantial increase in extreme temperature than mean temperature (O'Neill *et al.*, 2023). For example, Arctic amplification (increasing similarity of temperatures from the equator to the North pole, caused in part by the melting of Arctic sea ice) may alter the shape and position of the midlatitude jet stream, thereby contributing to an increase in the number of summer heat waves in Oregon (O'Neill *et al.*, 2023; Rupp and Schmittner, 2023). In addition, dry soils can amplify extreme heat through their relative lack of evaporative cooling (O'Neill *et al.*, 2023).

Here, we present projected changes in three metrics of extreme daytime heat (maximum temperature) and nighttime heat (minimum temperature) (Table 6) and compare how model projections compare to recent observations.

Table 6. Metrics and definitions of heat extremes.

Metric	Definition
Hot Days	Number of days per year on which maximum temperature is 90°F or higher
Warm Nights	Number of days per year on which minimum temperature is 65°F or higher
Hottest Day	Highest value of maximum temperature per year
Warmest Night	Highest value of minimum temperature per year
Daytime Heat Waves	Number of events per year in which the maximum temperature on at least three consecutive days is 90°F or higher
Nighttime Heat Waves	Number of events per year in which the minimum temperature on at least three consecutive days is 65°F or higher

The number of hot days and warm nights are projected to increase by the 2020s (2010–2039) and 2050s (2040–2069) relative to the 1971–2000 historical baseline under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios (Table 7, Figure 4, Figure 5).

From 1979 through 2005, an average of 4 days per year in Linn County were hot. The model-simulated average number of hot days per year from 1971 through 2000 also was 4 (Table 7, Figure 4). The observed annual number of hot days from 2010 through 2022, 8, agrees well with the projected average, assuming the higher emissions scenario, for the same time period (Figure 4). By the 2050s under the higher emissions scenario, the number of hot days, relative to each GCM's 1971–2000 historical baseline, is projected to increase by 5–29. The average number of hot days per year is projected to be 17 more than the average historical baseline of 4 days (Table 7). By the 2050s, the number of hot days per year is projected to be between 9 and 32 depending on the model and emissions

scenario (Figure 4). Projections that were based on the heat index, which includes relative humidity and can be more relevant to human health, are similar to those based on maximum temperature only. The projected change in average number of days per year with a heat index of 90°F or higher is projected to be 19 more than the average historical baseline of 3 days (Dalton and Loikith, 2021).

Table 7. Projected future changes in extreme heat metrics in Linn County. Changes from the 1971–2000 baseline were calculated for each of 20 global climate models and averaged across the 20 models (range in parentheses) for a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario and for the 2020s (2010–2039 average) and 2050s (2040–2069 average). The average projected change can be added to the average historical baseline to infer the average projected future value of a given variable.

	Average Historical Baseline	Change from baseline to 2020s		Change from baseline to 2050s	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
Hot Days	3.7 days	4.2 days (1.6-7.4)	5.8 days (2.5-8.3)	10.6 days (4.5-17.5)	17.4 days (4.9-28.6)
Warm Nights	0.3 days	0.5 days (0-1.3)	0.7 days (0-1.5)	1.7 days (0.1-4.5)	3.8 days (0.8-10.3)
Hottest Day	91.4°F	2.5°F (0.6-4)	3.2°F (1.1-5.4)	5.1°F (2.1-8.6)	6.8°F (1.9-9.8)
Warmest Night	61.3°F	2°F (0-3.8)	2.5°F (0.9-3.6)	4°F (1.2-6.8)	5.8°F (2.6-8.8)
Daytime Heat Waves	0.5 events	0.7 events (0.2-1.2)	0.9 events (0.4-1.4)	1.6 events (0.8-2.5)	2.5 events (0.8-3.5)
Nighttime Heat Waves	0 events	0 events (0-0.2)	0.1 events (0-0.2)	0.2 events (0-0.5)	0.5 events (0-1.3)

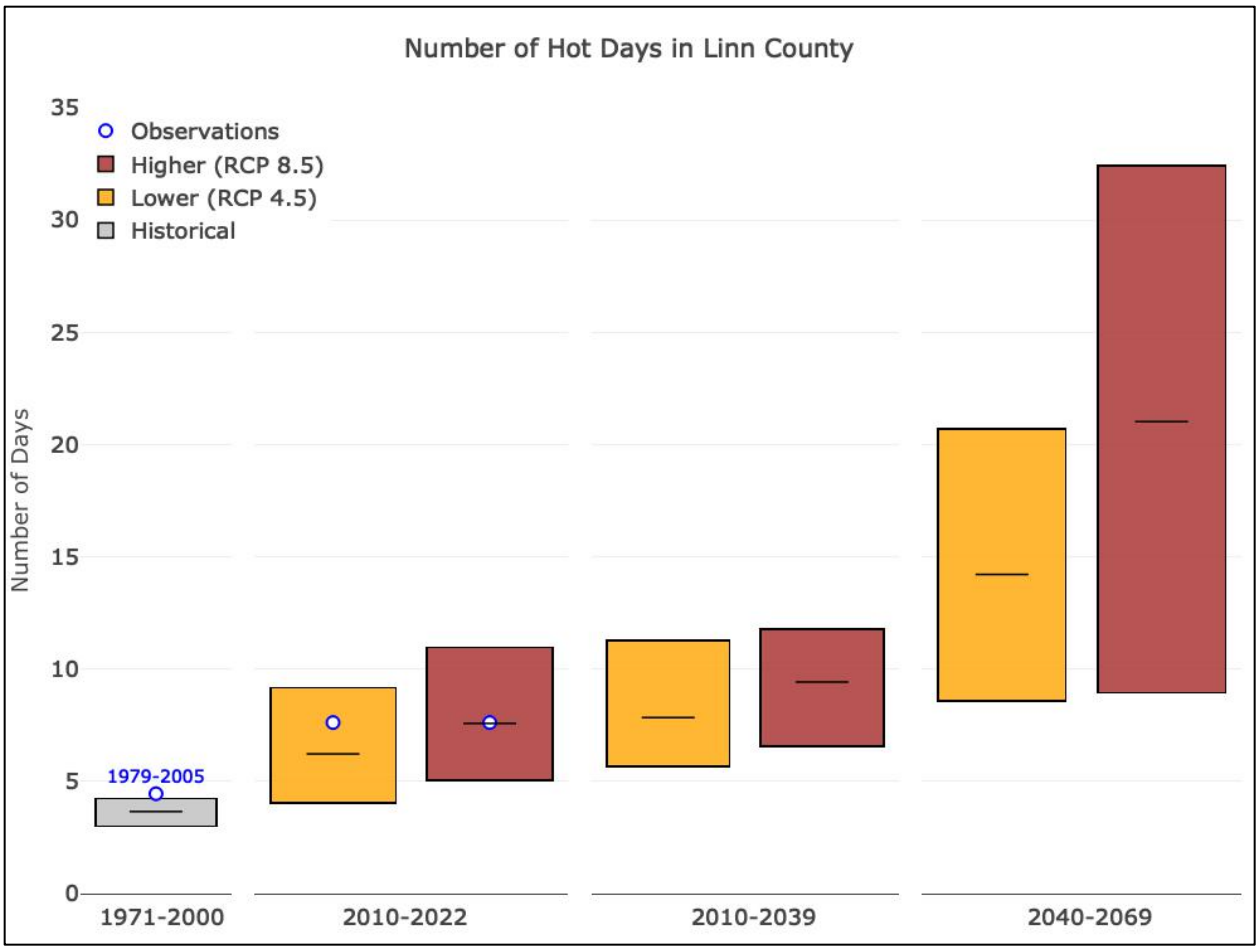

Figure 4. Projected number of hot days in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected values, and blue circles represent the mean observed values. Hot days are those on which the maximum temperature is 90°F or higher.

The observed annual number of warm nights in Linn County averaged over 1979–2005, less than 1, agrees well with the model-simulated 1971–2000 average value (Table 7, Figure 5). The observed annual number of warm nights from 2010–2022 was close to 1, which also agrees well with the average projections for those years assuming the higher emissions scenario (Figure 5). By the 2050s under the higher emissions scenario, the number of warm nights, relative to each GCM's 1971–2000 historical baseline, is projected to increase by 1 to 10. The average number of warm nights per year is projected to be 4 more than the average historical baseline of virtually zero (Table 7). The number of warm nights per year by the 2050s is projected to be between 1 and 11 depending on the model and emissions scenario (Figure 5).

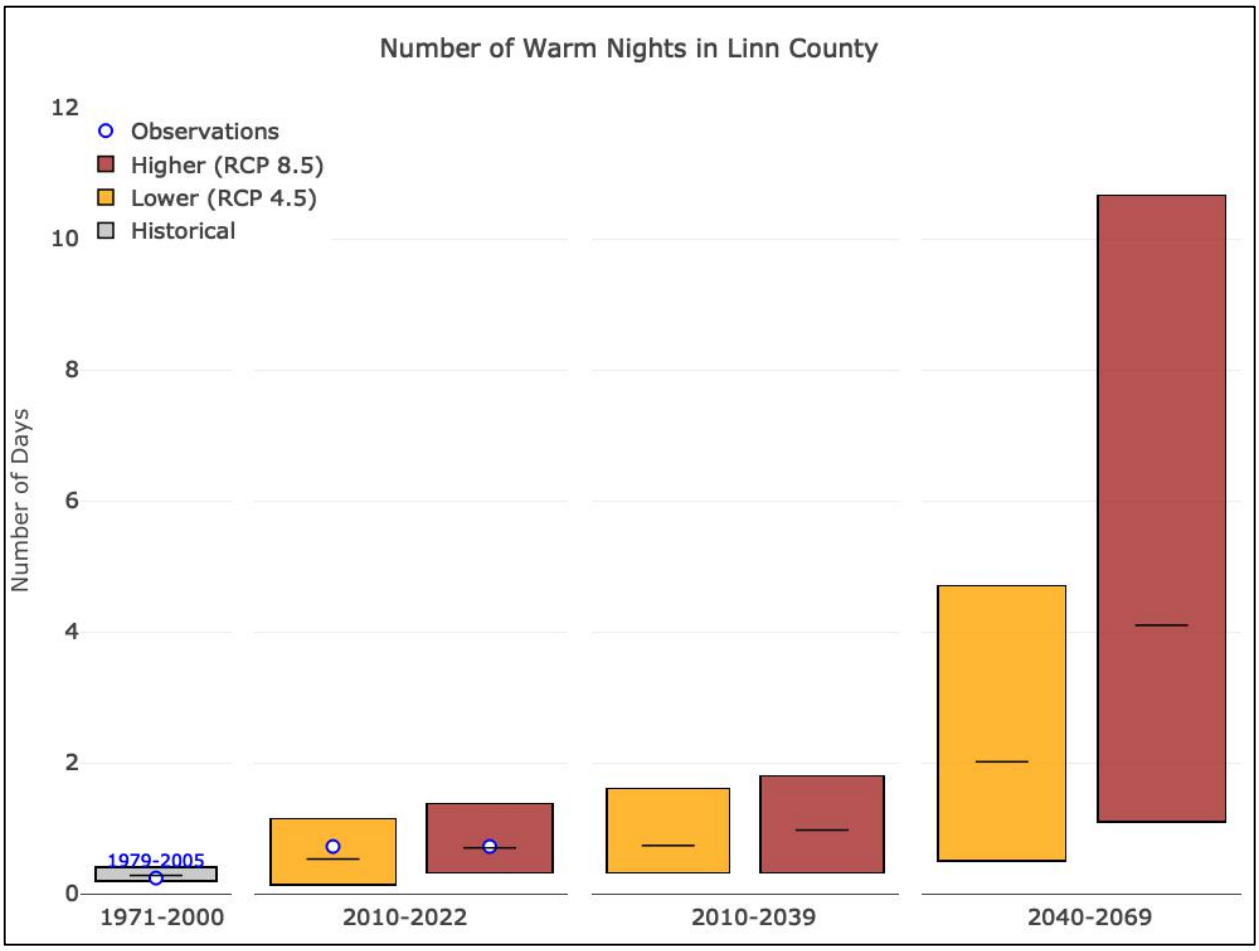

Figure 5. Projected number of warm nights in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values. Warm nights are those on which the minimum temperature is 65°F or higher.

The temperatures on the hottest day and warmest night are projected to increase by the 2020s (2010–2039) and 2050s (2040–2069) under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios (Table 7, Figure 6, Figure 7).

The averaged observed temperature on the hottest day of the year in Linn County from 1979 through 2005 was 91.9°F. This value agrees well with the model-simulated value over the same time period (91.7°F), although it is about half a degree warmer than the modeled 1971–2000 value (Table 7, Figure 6). The average observed temperature on the hottest day from 2010 through 2022, 94.6°F, is 0.7°F warmer than the average projected temperature for those years, assuming the higher emissions scenario (Figure 6). By the 2050s, under the higher emissions scenario, the temperature on the hottest day of the year is projected to increase by 1.9–9.8°F relative to the GCMs' historical baselines. The average projected increase in temperature on the hottest day is 6.8°F above the average historical baseline of 91.4°F (Table 7). The average temperature on the hottest day of the year from 2040–2069

is projected to be between 94.2° and 101.7°F depending on the model and emissions scenario (Figure 6).

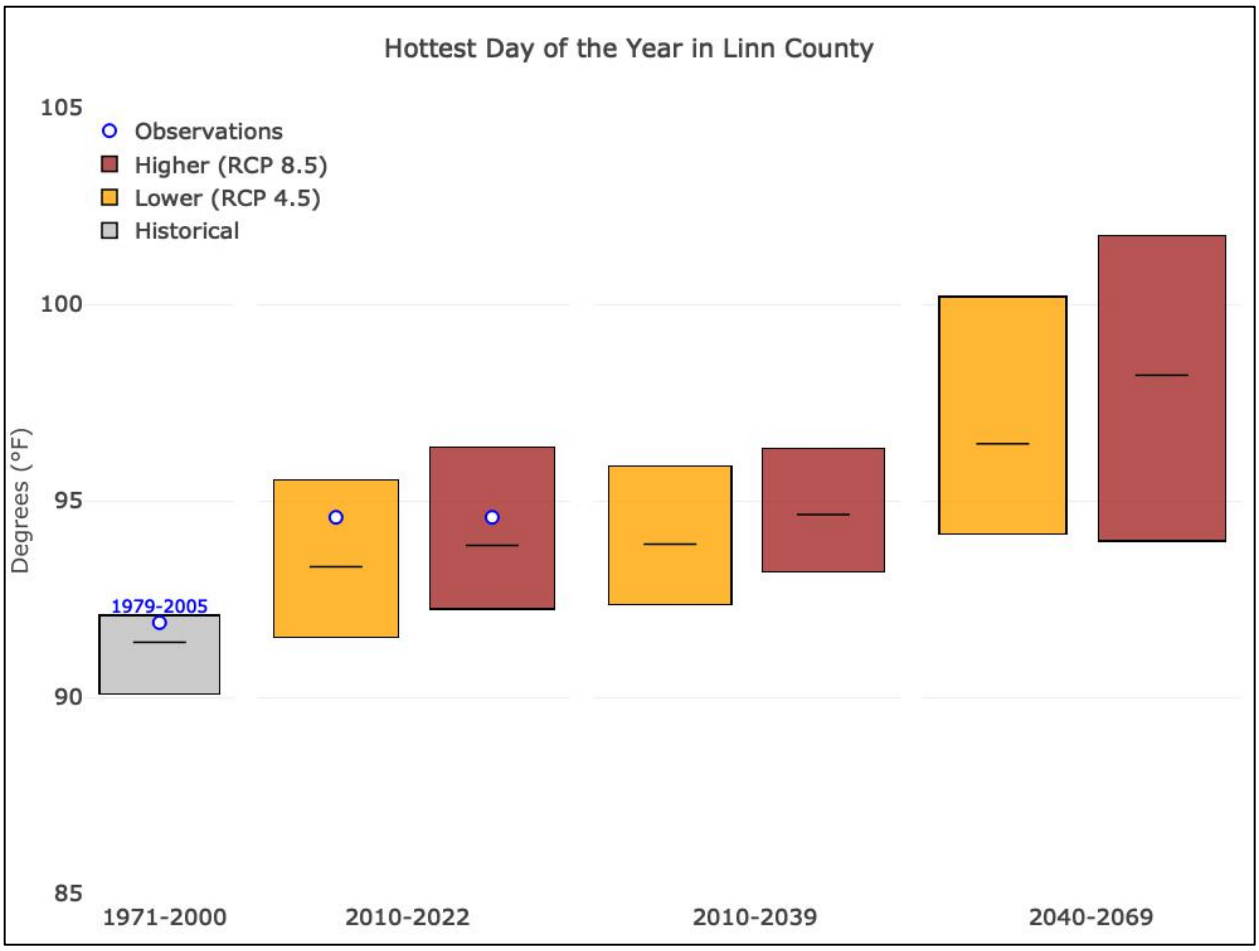

Figure 6. Projected temperature on the hottest day of the year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values.

The annual observed temperature on the warmest night of the year in Linn County from 1979 through 2005, 61.4°F, agrees well with the model-simulated value over the same time period (61.5°F). The observed value is about a tenth of a degree warmer than the modeled 1971–2000 value (Table 7, Figure 7). The average observed temperature on the warmest night of the year from 2010 through 2022, 62.1°F, is 1.1°F cooler than the average projected temperature for those years, assuming the higher emissions scenario (Figure 7). By the 2050s, under the higher emissions scenario, the temperature on the warmest night of the year is projected to increase by 2.6–8.8°F relative to the GCMs' historical baselines. The average temperature on the warmest night is 5.8°F above the average historical baseline of 61.3°F (Table 7). The average temperature on the warmest night of the year

from 2040 through 2069 is projected to be 62.8° to 70.6°F depending on the model and emissions scenario (Figure 7).

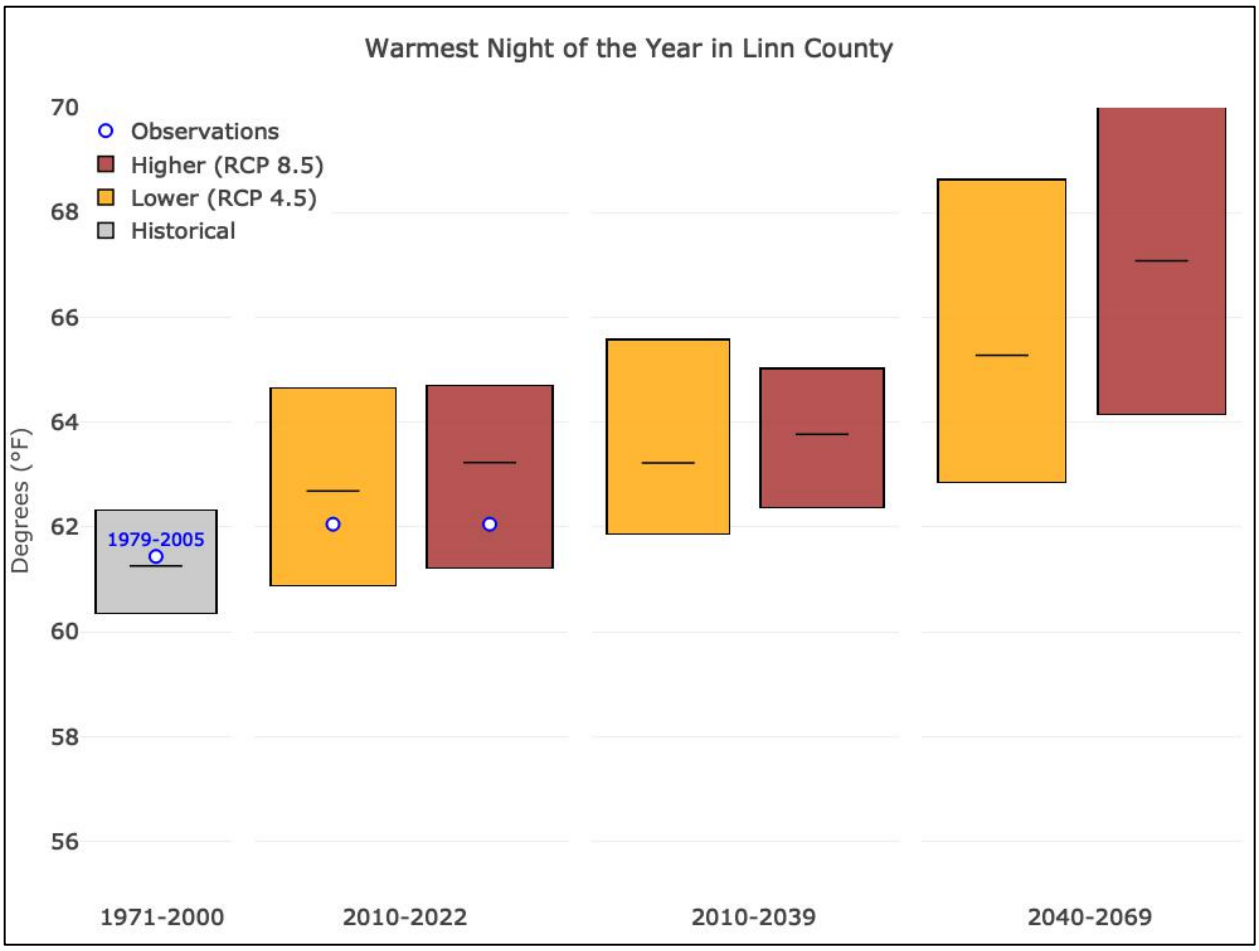

Figure 7. Projected temperature on the warmest night of the year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values.

The average observed number of daytime and nighttime heat waves in Linn County is less than one per year (Table 7, Figure 8, Figure 9). Under the higher emissions scenario, the numbers of daytime and nighttime heat waves are projected to increase by 0.8–3.4 and 0.0–1.8, respectively, by the 2050s relative to the GCMs' historical baselines (Table 7). The average number of daytime and nighttime heat waves per year is projected to be about 3 and 0.5, respectively (Table 7, Figure 8, Figure 9).

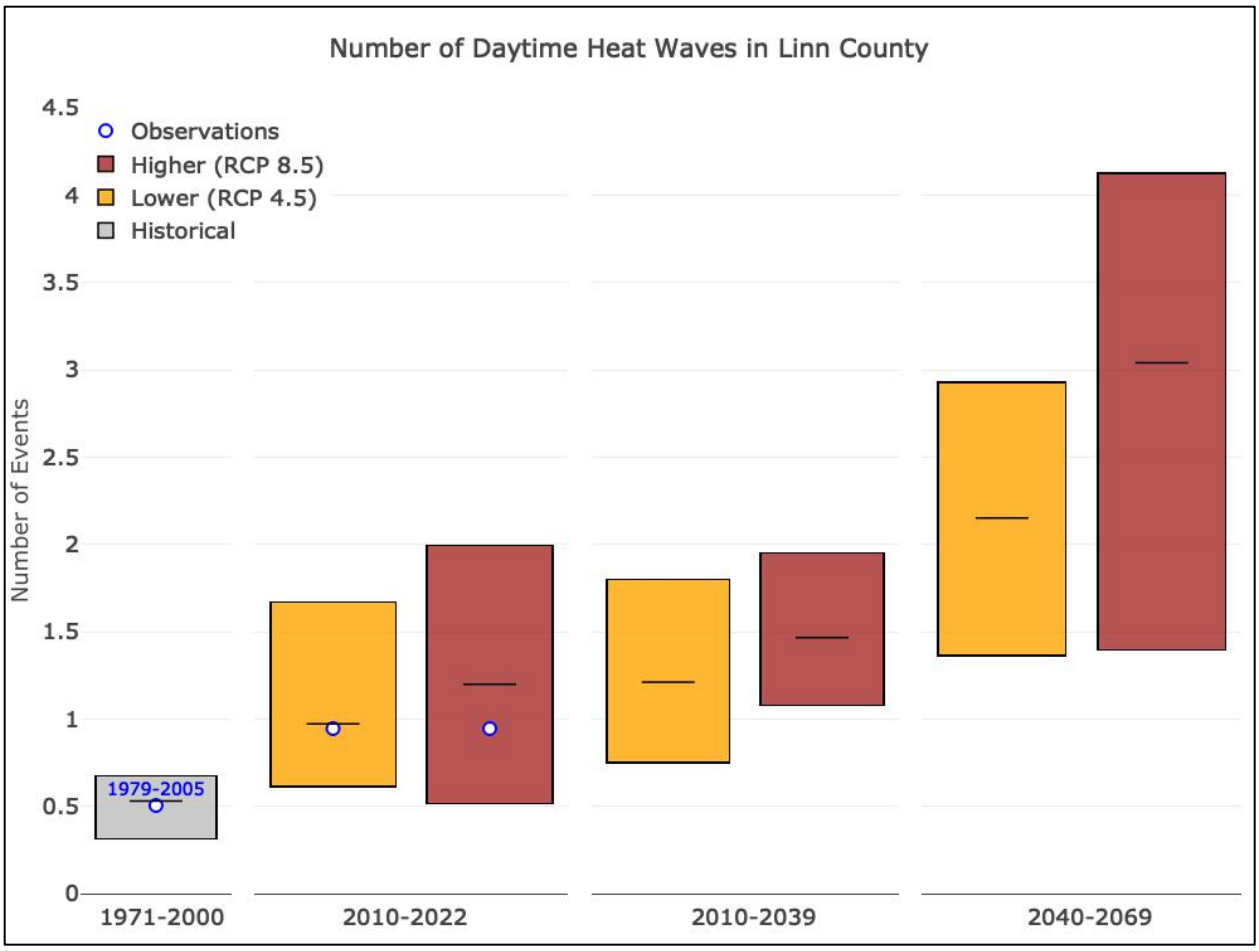

Figure 8. Projected number of daytime heat waves per year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values. Daytime heat waves are defined as three or more consecutive days on which the maximum temperature is 90°F or higher.

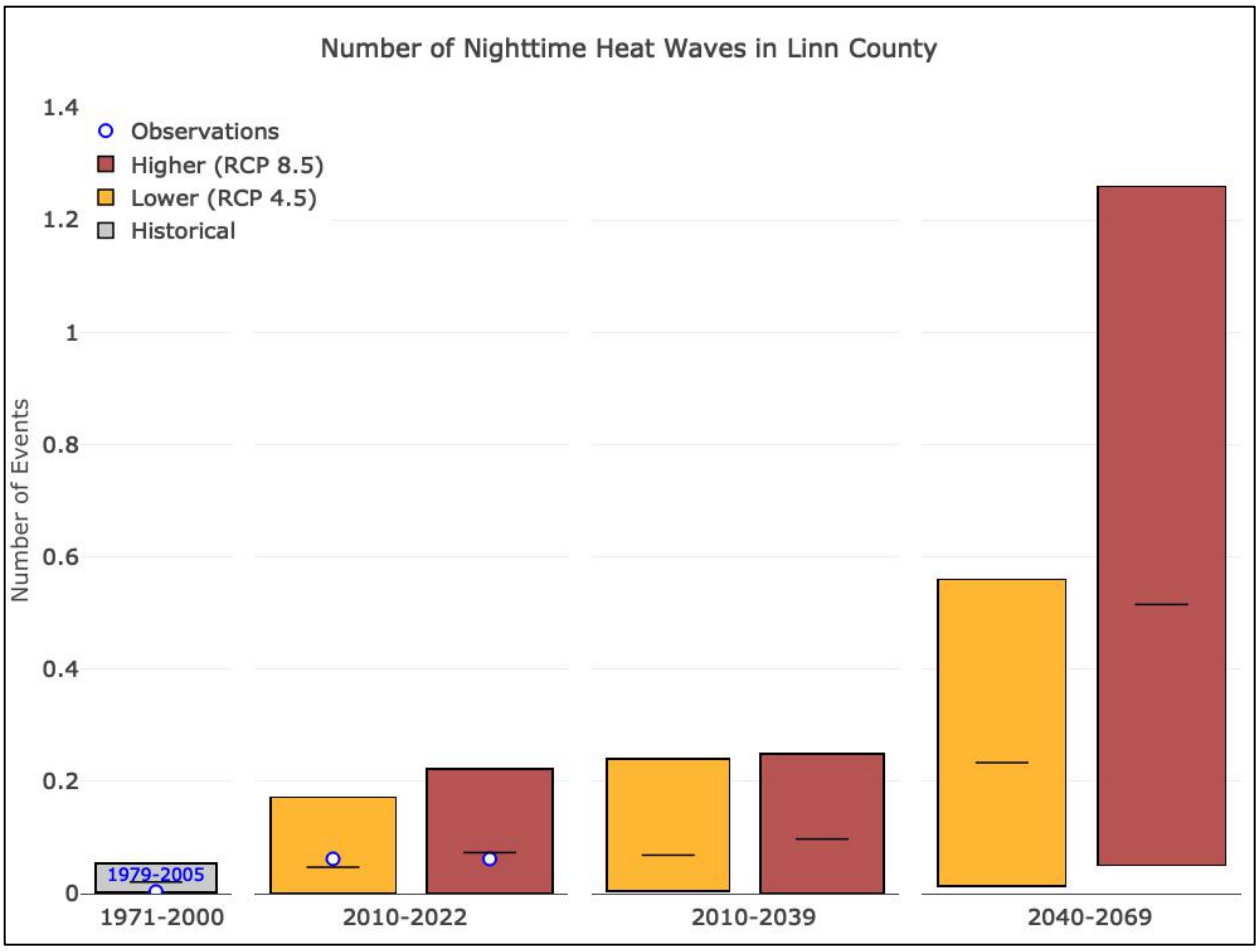

Figure 9. Projected number of nighttime heat waves per year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values. Nighttime heat waves are three or more consecutive days on which the minimum temperature is 65°F or higher.

Potential Effects of Extreme Heat on People

Certain populations are considered at particularly high risk of heat-related illness and death; extreme heat also exacerbates interpersonal violence (Miles-Novelo and Anderson, 2019; Stechemesser *et al.*, 2022). These populations include outdoor workers in agriculture, forestry, and other sectors; residents of urban heat islands; people with preexisting conditions or without housing or air conditioning; pregnant people; older adults; children; low-income communities; and communities of color (York *et al.*, 2020; Ho *et al.*, 2021). Here, we focus on potential future changes in the number of people in Linn County that may be exposed to extreme heat. Clear information on the health effects of extreme heat on high-risk populations, and ways to prepare and recover from extreme heat, is available from numerous sources, including the Oregon Health Authority (www.oregon.gov/oha/ph/preparedness/prepare/pages/prepareforextremeheat.aspx)

and U.S. Centers for Disease Control and Prevention (www.cdc.gov/disasters/extremeheat/index.html)

Outdoor workers. The U.S. Bureau of Labor Statistics tracks occupational employment and wages in Albany, but not in Linn County as a whole. As of May 2022, an estimated 520 individuals were employed in farming, fishing, and forestry and 2470 were employed in construction and extraction. The Oregon Employment Department includes Linn, Marion, Polk, and Yamhill Counties in its Mid Valley employment data and projections (OED, 2023). Within the Mid Valley in 2021, an estimated 11,115 individuals were employed in farming, fishing, and forestry and 17,216 were employed in construction and extraction. Employment in those two sets of occupations was projected to increase by 5% and 15%, respectively, by 2031. As of 2018, an estimated 710 migrant farmworkers (including those producing livestock) and 1409 seasonal farmworkers were employed in Linn County (Rahe, 2018). The counties in which people are employed and reside are not always the same.

Urban areas. As of 2020, about 73% of Linn County's population (92,894 people) lived within the urban growth boundaries (within county limits, where applicable) of Albany, Brownsville, Gates, Halsey, Harrisburg, Idanha, Lebanon, Lyons, Mill City, Millersburg, Scio, Sodaville, Sweet Home, Tangent, and Waterloo (PRC, 2023b). A projected 76% and 81% of the county's residents will live within urban growth boundaries by 2040 and 2070, respectively (PRC, 2023b). Because few of the areas within urban growth boundaries have more than 5000 residents, however, 50% of the county's population is considered to live in rural areas (PCH, 2023).

Preexisting conditions. In 2020, Linn County's age-adjusted prevalence of many preexisting conditions that could be exacerbated by extreme heat ranged from about 6% to 29% (Table 8). Age-adjusted prevalence data allow for comparisons in space or time as age distributions vary. These data were provided by the PLACES project, a collaboration between the U.S. Centers for Disease Control and Prevention (CDC) and Robert Wood Johnson Foundation. PLACES reports measures of chronic diseases at the county level across the United States (chronicdata.cdc.gov/500-Cities-Places/PLACES-Local-Data-for-Better-Health-County-Data-20/swc5-untb). Data are derived from the Behavior Risk Factor Surveillance System (BRFSS), sponsored by the CDC's National Center for Chronic Disease Prevention and Health Promotion, other CDC centers, and federal agency partners; and the U.S. Census.

In the 2022 health rankings for Oregon counties, Linn ranked 16th with respect to health outcomes (e.g., measures of length and quality of life) and 17th with respect to health factors (e.g., health behaviors, clinical care, social and economic factors, and physical environment) (PCH, 2023). The numbers of primary care professionals and behavioral health professionals per 10,000 county residents in 2020, 10.3 and 7.0, respectively, were lower than the 15.7 and 7.0 across Oregon.

Table 8. Prevalence of preexisting conditions among adults (aged 18 and older) in Linn County, Oregon, in 2020 (blood pressure data are from 2019). Data source: PLACES project.

Preexisting condition	Age-adjusted prevalence (%)	
	Value	Range (95% confidence limit)
Chronic obstructive pulmonary disease	6.4	5.5–7.4
Coronary heart disease	5.8	5.2–6.3
Current asthma	11.3	10.7–11.9
Fair or poor self-rated health status	13.9	12.2–15.8
Physical health not good for ≥14 days	10.3	9.4–11.4
High blood pressure	29.2	28.1–30.3
Depression	22.4	21.2–23.6
Mental health not good for ≥14 days	16.2	15.1–17.3

Without housing or air conditioning. As of 2017, an estimated 180 people in Linn County (1.4 per 1000 residents) were unhoused (OHA, 2019). A separate estimate indicated that 45.0 per 1000 students enrolled in kindergarten through grade 12, or about 1024 children, were unhoused (OHA, 2019). Statewide, an estimated 34% of housing units did not have air conditioning in 2020 (EIA, 2022).

High-risk life stage or age class. The annual number of live births per 1000 women or gestational parents in Linn County from 2018–2020 ranged from 11.4 to 12.0, which was higher than the statewide numbers (9.3–10.1) (PCH, 2023). The number of teen (ages 15–19) pregnancies per year, 15.3–20.0 per 1000, also was higher than the statewide number (14.5–18.9) (PCH, 2023).

The percentage of Linn County residents aged 65 and older from 2016–2020, 18.6% (Table 3), was similar to the statewide estimate of 19% in 2020. The percentage of older residents likely will continue to increase (PRC, 2023c). Statewide, the percentage of residents under the age of 15 is projected to decrease from 17% in 2020 to 14% in 2045 (PRC, 2023c). If trends in Linn County are similar, then the projected number of residents aged 15 and younger will decrease by 213 (1%) from 2020 to 2045 (PRC, 2023b).

Low income. Income inequality sometimes is characterized as the ratio of income at the 80th to the 20th percentiles. Linn County's ratio from 2016–2020, 3.9, was lower than the statewide ratio of 4.5 (PCH, 2023). During that time, 18.6% of households in the county received benefits from the Supplemental Nutrition Assistance Program, as compared to 49.9% across Oregon. From 2018–2020, 11.7–13.1% of the county's residents, and 16.7–18.6% of those under age 18 (as compared to 9.8–11.9% of all Oregon residents and 13.2–18.6% of those under 18), were food insecure at some point in time.

Communities of color. An estimated 18.6% of Linn County's population identify as non-White (U.S. Census Bureau, 2023).

Summary

The number, duration, and intensity of extreme heat events will increase as temperatures continue to warm. In Linn County, the number of extremely hot days (those on which the temperature is 90°F or higher) and the temperature on the hottest day of the year are projected to increase by the 2020s and 2050s under both the lower and higher emissions scenarios. The number of days per year with temperatures 90°F or higher is projected to increase by an average of 17 (range 5–29) by the 2050s, relative to the 1971–2000 historical baseline, under the higher emissions scenario. The temperature on the hottest day of the year is projected to increase by an average of about 7°F (range 2–10°F) by the 2050s. Projected demographic changes, such as an increase in the proportion of older adults, will increase the number of people in some of the populations that are at greatest risk from extreme heat.

Cold Waves

Extremely cold temperatures in Oregon generally occur when Arctic air moves into the state from the north and east (O'Neill *et al.*, 2023). As a result of human-caused climate change, Arctic temperature is warming more rapidly than the global mean temperature. Therefore, the intensity and frequency of cold extremes in the Northwest and worldwide decreased over the past century (Vose *et al.*, 2017; IPCC, 2021; O'Neill *et al.*, 2023). At many locations across Oregon, the annual number of days on which the minimum temperature is below freezing has decreased significantly since 1940 (O'Neill *et al.*, 2023).

The frequency of cold extremes is expected to continue decreasing (Vose *et al.*, 2017; IPCC, 2021), although more slowly than the frequency of heat extremes will increase (O'Neill *et al.*, 2023). Extreme cold will still be possible during the next several decades, but will become increasingly rare as winter temperatures warm and become less variable (O'Neill *et al.*, 2023; Rupp and Schmittner, 2023).

Older adults, infants and children, rural residents, unhoused individuals, and people with preexisting cardiovascular or respiratory conditions are considered most susceptible to extreme cold (Conlon *et al.*, 2011; NCHH, 2022). Recent and projected estimates of these populations are summarized in *Heat Waves*.

Here, we present projected changes in three metrics of extreme daytime cold (maximum temperature) and nighttime cold (minimum temperature) (Table 9) and compare how projections compare to recent observations.

Table 9. Metrics and definitions of cold extremes.

Metric	Definition
Cold Days	Number of days per year on which the maximum temperature is 32°F or lower
Cold Nights	Number of days per year on which the minimum temperature is 0°F or lower
Coldest Day	Lowest value of maximum temperature per year
Coldest Night	Lowest value of minimum temperature per year
Daytime Cold Waves	Number of events per year in which maximum temperature on at least three consecutive days is 32°F or lower
Nighttime Cold Waves	Number of events per year in which minimum temperature on at least three consecutive days is 0°F or lower

The number of cold days and nights in Linn County is projected to decrease by the 2020s (2010–2039) and 2050s (2040–2069) relative to the 1971–2000 historical baseline under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios (Table 10, Figure 10).

The average observed annual number of cold days in Linn County from 1979–2005, 7, is 2 more days than the average model-simulated value from 1971 through 2000, 5 days (Table 10, Figure 10). The observed average annual number of cold days from 2010 through 2022,

6, is about 3 more than the average projected value for that period given either emissions scenario (Figure 10). By the 2050s under the higher emissions scenario, the number of cold days is projected to decrease by 2 to 5 days relative to each GCM's 1971–2000 historical baseline. The average projected number of cold days per year is 4 less than the average historical baseline of 5 days. The average number of cold days by the 2050s is projected to be about 1 to 3 days per year depending on the model and emissions scenario (Figure 10). Nighttime temperatures in Linn County rarely are lower than 0°F.

Table 10. Projected future changes in extreme cold metrics in Linn County. Changes from the 1971–2000 baseline were calculated for each of 20 global climate models and averaged across the 20 models (range in parentheses) for a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario and for the 2020s (2010–2039 average) and 2050s (2040–2069 average). The average projected change can be added to the average historical baseline to infer the average projected future value of a given variable.

	Average Historical Baseline	Change from baseline to 2020s		Change from baseline to 2050s	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
Cold Days	5 days	-1.6 days (-3.3 - 0.6)	-2.3 days (-3.7 - -0.8)	-3 days (-4.2 - -1.3)	-3.5 days (-5 - -1.6)
Cold Nights	0.2 days	0 days (-0.1 - 0.3)	0 days (-0.1 - 0.2)	-0.1 days (-0.2 - 0.1)	-0.1 days (-0.2 - 0)
Coldest Day	29.1°F	1.2°F (-2.8 - 3.3)	2.4°F (-1.4 - 4.8)	3.8°F (0.3 - 7.2)	4.9°F (1.3 - 8.2)
Coldest Night	13.4°F	1.6°F (-1.6 - 5.4)	3.2°F (-0.5 - 7.4)	4.8°F (0.8 - 8.8)	6°F (0.6 - 10.5)
Daytime Cold Waves	0.6 events	-0.2 events (-0.4 - 0.1)	-0.3 events (-0.5 - -0.1)	-0.4 events (-0.5 - -0.1)	-0.4 events (-0.6 - -0.2)
Nighttime Cold Waves	0 events	0 events	0 events	0 events	0 events

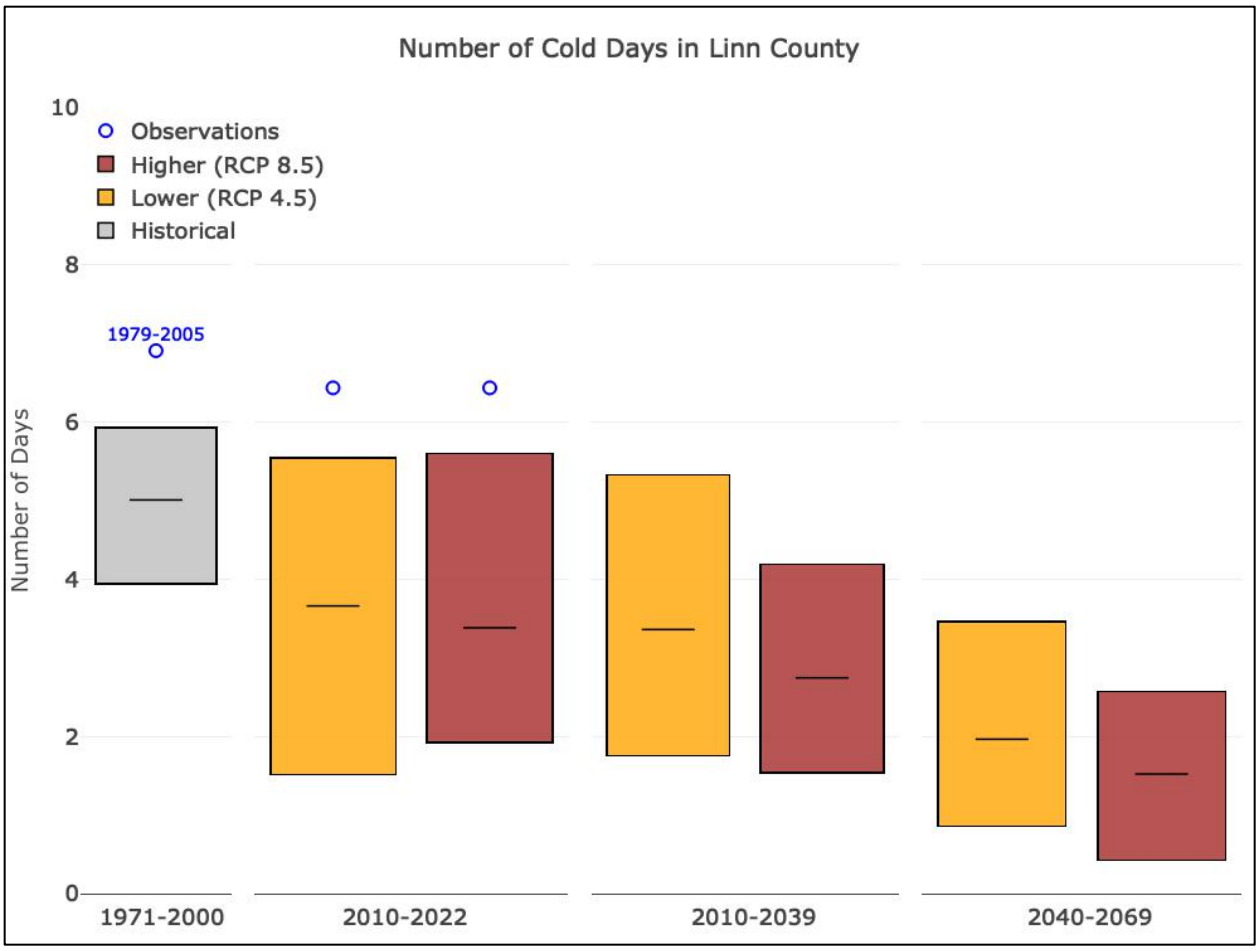

Figure 10. Projected number of cold days in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values. Cold days are those on which the maximum temperature is 32°F or lower.

The temperatures on the coldest day and night are projected to increase by the 2020s and 2050s under both emissions scenarios (Table 10, Figure 11, Figure 12).

The averaged observed temperature on the coldest day of the year in Linn County from 1979 through 2005, 29.8°F, is 0.6°F warmer than the model-simulated value over the same time period (29.2°F). The modeled 1971–2000 average value is 29.1°F (Table 10, Figure 11). The average observed temperature on the coldest day of the year from 2010 through 2022, 29.5°F, is about 1.1°F cooler than the average projected temperature for those years, assuming the higher emissions scenario (Figure 11). By the 2050s, under the higher emissions scenario, the temperature on the coldest day of the year is projected to increase by 1.3 to 8.2°F relative to the GCMs' historical baselines. The average projected increase in temperature on the coldest day is 4.9°F above the average historical baseline of 29.1°F (Table 10). The average temperature on the coldest day of the year from 2040 through

2069 is projected to be 30.6 to 37.1°F depending on the model and emissions scenario (Figure 11).

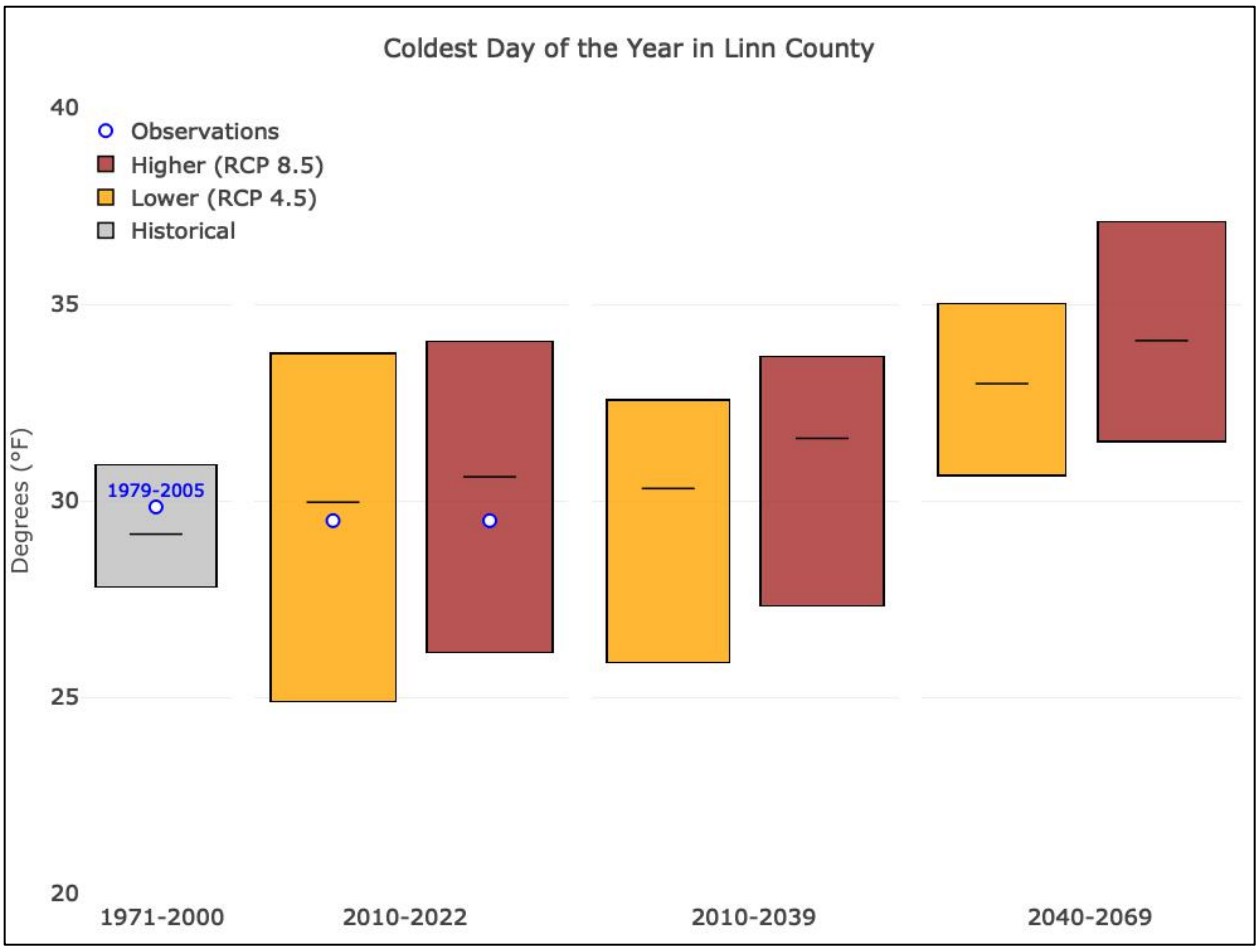

Figure 11. Projected temperature on the coldest day of the year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values.

The averaged observed temperature on the coldest night of the year in Linn County from 1979 through 2005, 13.2°F, is 0.3°F cooler than the simulated value over the same time period (13.5°F). The average simulated value from 1971 through 2000 is 13.4°F (Table 10, Figure 12). The average observed temperature on the coldest night of the year from 2010 through 2022, 14.7°F, is about 0.8°F cooler than the average projected value for those years, assuming the higher emissions scenario (Figure 12). By the 2050s, under the higher emissions scenario, the temperature on the coldest night of the year is projected to increase by 0.6–10.5°F relative to the GCMs' historical baselines. The average projected increase in the temperature on the coldest night is 6.0°F above the average historical baseline of 13.4°F (Table 10). The average temperature on the coldest night of the year from 2040 through 2069 is projected to be between 15.5 and 23.5°F depending on the

model and emissions scenario (Figure 12). Daytime and nighttime cold waves are rare in Linn County (Table 10).

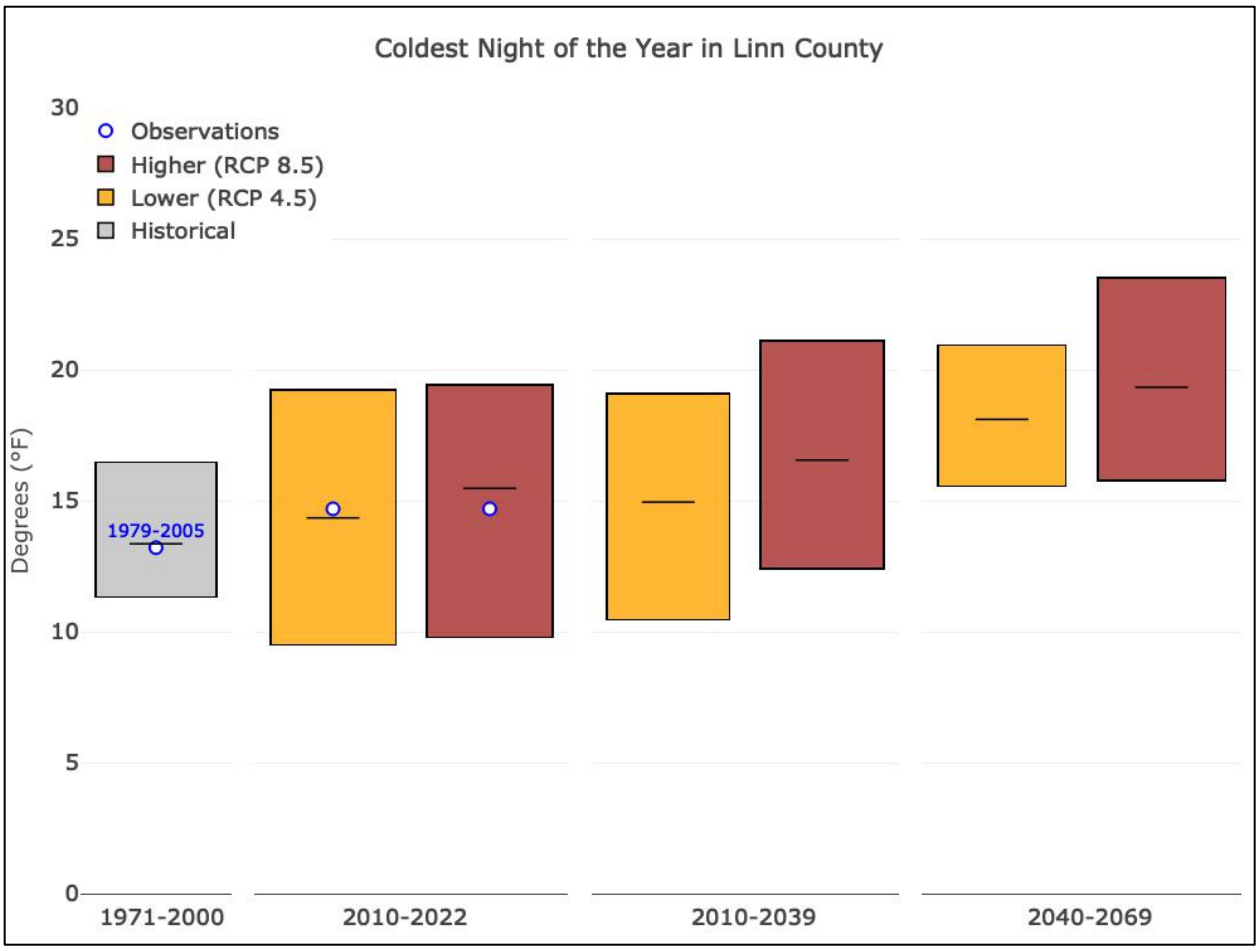

Figure 12. Projected temperature on the coldest night of the year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values.

Freezing Rain and Ice Accretion

Freezing rain forms when water droplets that are super-cooled, or that remain liquid even at temperatures below freezing, freeze on contact with a surface (Degelia *et al.*, 2016). Ice accretion refers to the process by which a layer of ice accumulates on solid objects that are exposed to freezing rain, drizzle, or fog. Because freezing rain intensities tend to be low, only long-duration events typically lead to appreciable ice accretion on surfaces (McCray *et al.*, 2019).

Published observations of ice loads from freezing rain on structures are rare (Changnon and Creech, 2003). The frequency of freezing rain is projected to increase over most of Canada and decrease over most of the eastern and central United States during the twenty-

first century (Lambert and Hansen, 2011; Klima and Morgan, 2015; Jeong and Sushama, 2018; McCray *et al.*, 2022). Little change or some increase in the frequency of freezing rain, even under high warming scenarios, is projected in the Intermountain West, including parts of eastern Oregon. In coastal Oregon and Washington, by contrast, the projected frequency of freezing rain declines in the future (Jeong *et al.*, 2018; McCray *et al.*, 2022). Even so, whether the amount of freezing rain will increase or decrease is unclear, and varies among climate models, emissions scenarios, and temporal extents (Jeong *et al.*, 2018). One analysis projected decreases in the amount of ice accretion with a 50-year return period (a 2% probability of occurring in any given year) over southwestern and central-western Oregon, but no change in northern Oregon (Jeong *et al.*, 2019). Moreover, published projections of freezing rain trends usually have been provided as maps covering extensive areas (e.g., the conterminous United States or Canada, the United States, and northern Mexico), making it difficult to quantify county-level average projections.

Summary

Cold extremes will become less frequent and intense as the climate warms. The number of cold days (maximum temperature 32°F or lower) per year in Linn County is projected to decrease by an average of 4 (range 2–5) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario. The temperature on the coldest night of the year is projected to increase by an average of 6°F (range 1–11°F) by the 2050s. The number of county residents at greatest risk from extreme cold is likely to grow, although this increase may be offset somewhat by the decrease in incidence of cold extremes.

Heavy Precipitation

Projections of future precipitation are less certain than projections of future temperature. Precipitation has high natural variability, and the atmospheric patterns that influence precipitation are represented differently among GCMs. Globally, mean precipitation is likely to decrease in many dry regions in the subtropics and mid-latitudes and to increase in many mid-latitude wet regions (IPCC, 2013; Stevenson *et al.*, 2022). Because the location of the boundary between mid-latitude increases and decreases in precipitation varies among GCMs, some models project increases and others decreases in precipitation in Oregon (Mote *et al.*, 2013; Kim *et al.*, 2022). Projections of precipitation in the Northwest can be highly sensitive to the source of data used to train the downscaling (see *Appendix*) (Wang *et al.*, 2020a; Kim *et al.*, 2022).

Observed annual precipitation in Oregon is highly variable and has not changed significantly over the period of record. Annual precipitation in Oregon is projected to increase somewhat over the twenty-first century, although natural variability will continue to dominate this trend (Dalton *et al.*, 2017, 2021; Fleishman, 2023). On average, summers in Oregon are projected to become drier and other seasons to become wetter. However, some models project increases and others decreases in each season (Dalton *et al.*, 2017, 2021; Fleishman, 2023). In addition, regional climate models project larger increases in winter precipitation east of the Cascade Range than west of the Cascade Range, which suggests a weakened rain shadow effect in winter (Mote *et al.*, 2019).The downscaled climate data from which our projections are derived (see *Appendix*) result in higher projected precipitation east of the Cascade Range than some other data sources, and differences in modeled precipitation among climate models are particularly large east of the Cascade Range (Jiang *et al.*, 2018).

Extreme precipitation in the Northwest is governed by atmospheric circulation and its interaction with complex topography (Parker and Abatzoglou, 2016). Atmospheric rivers—long, narrow swaths of warm, moist air that carry large amounts of water vapor from the tropics to mid-latitudes—generally result in extreme precipitation across large areas west of the Cascade Range, and are associated with the majority of fall and winter extreme precipitation events in Oregon. By contrast, low pressure systems that are not driven by offshore westerly flows often lead to locally extreme precipitation east of the Cascade Range (Parker and Abatzoglou, 2016).

The frequency and intensity of heavy precipitation has increased across most continents since the 1950s (IPCC, 2021). Observed trends in the frequency of extreme precipitation across Oregon vary among locations, time periods, and metrics, but overall, the frequency has not changed substantially. As the atmosphere warms, it holds more water vapor. As a result, the frequency and intensity of extreme precipitation is expected to increase (Dalton *et al.*, 2017, 2021; Kossin *et al.*, 2017). Regional climate models project a larger percentage increase in precipitation extremes east of the Cascade Range than west of the Cascade Range (Mote *et al.*, 2019; Rupp *et al.*, 2022). Additionally, the projected percentage increase in extreme precipitation tends to be larger on the leeward side of the Coast and Cascade Ranges than on the windward side (Rupp *et al.*, 2022). Climate models also project an increase in the number of days on which an atmospheric river is present, and an increase in

the proportion of total annual precipitation across the Northwest that is delivered by atmospheric rivers (Dalton *et al.*, 2021).

Here, we present projected changes in four metrics of precipitation extremes (Table 11).

Table 11. Metrics and definitions of precipitation extremes.

Metric	Definition
Wettest Day	Highest one-day precipitation total per water year (1 October–30 September)
Wettest Five Days	Highest consecutive five-day precipitation total per water year
Wet Days	Number of days per water year on which precipitation exceeds 0.75 inches
Landslide Risk Days	Number of days per water year that exceed the landslide threshold developed by the US Geological Survey for Seattle, Washington (see https://pubs.er.usgs.gov/publication/ofr20061064). P3/(3.5-.67*P15)>1, where ▪ P3 = Precipitation accumulation on prior days 1–3 ▪ P15 = Precipitation accumulation on prior days 4–18

In Linn County, the amount of precipitation on the wettest day and wettest consecutive five days per year is projected to increase on average by the 2020s (2010–2039) and 2050s (2040–2069), relative to the 1971–2000 historical baseline, under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios (Table 12, Figure 13, Figure 14). Some models project decreases in these metrics for certain time periods and scenarios.

The average observed amount of precipitation on the wettest day of the year from 1979 through 2005, 2.45 inches, is 0.3 inches less than the model-simulated 1971–2000 average, 2.75 inches (Table 12, Figure 13). The observed amount of precipitation on the wettest day of the year from 2010–2022 was 2.24 inches. By contrast, projected precipitation on the wettest day of the year from 2010–2022 under both emissions scenarios increased relative to the historical baseline (Figure 13). The difference in direction between observed and projected values does not necessarily mean that the projections are unreliable. Because annual precipitation is highly variable, it is possible to detect a short-term (~10–15 years) decreasing trend within a longer-term increasing trend. Additionally, Oregon's latitude is within the region in which some global climate models project increases and others project decreases in precipitation. By the 2050s under the higher emissions scenario, the amount of precipitation on the wettest day of the year, relative to each GCM's 1971–2000 historical baseline, is projected to change by -0.6–34.9% (Table 12). The average projected amount of precipitation on the wettest day of the year is 13.7% greater than the average historical baseline of 2.7 inches. The amount of precipitation on the wettest day of the year by the 2050s is projected to be 2.78 to 3.66 inches depending on the model and emissions scenario (Figure 13).

Table 12. Projected future changes in extreme precipitation metrics in Linn County. Changes from the 1971–2000 baseline were calculated for each of 20 global climate models and averaged across the 20 models (range in parentheses) for a lower (RCP 4.5) and higher (RCP 8.5) emissions scenario and for the 2020s (2010–2039 average) and 2050s (2040–2069 average). The average projected change can be added to the average historical baseline to infer the average projected future value of a given variable.

	Average Historical Baseline	Change from baseline to 2020s		Change from baseline to 2050s	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
Wettest Day	2.7 inches	7.9% (-6-21.4)	5.7% (-5.4-21.2)	11.6% (2.4-23.3)	13.7% (-0.6-34.9)
Wettest Five-Days	6.9 inches	5.2% (-7.8-17.9)	3.4% (-7.3-17.9)	8.2% (-3.4-24.8)	9.6% (-0.9-21.5)
Wet Days	27.4 days	0.3 days (-2.3-2.6)	-0.3 days (-3.6-1.6)	0.6 days (-3.4-3.4)	0.5 days (-4.5-3.7)
Landslide Risk Days	31 days	-0.2 days (-3.5-3.2)	-0.5 days (-3-1.7)	-0.7 days (-3.8-1.9)	-0.5 days (-3.1-3.5)

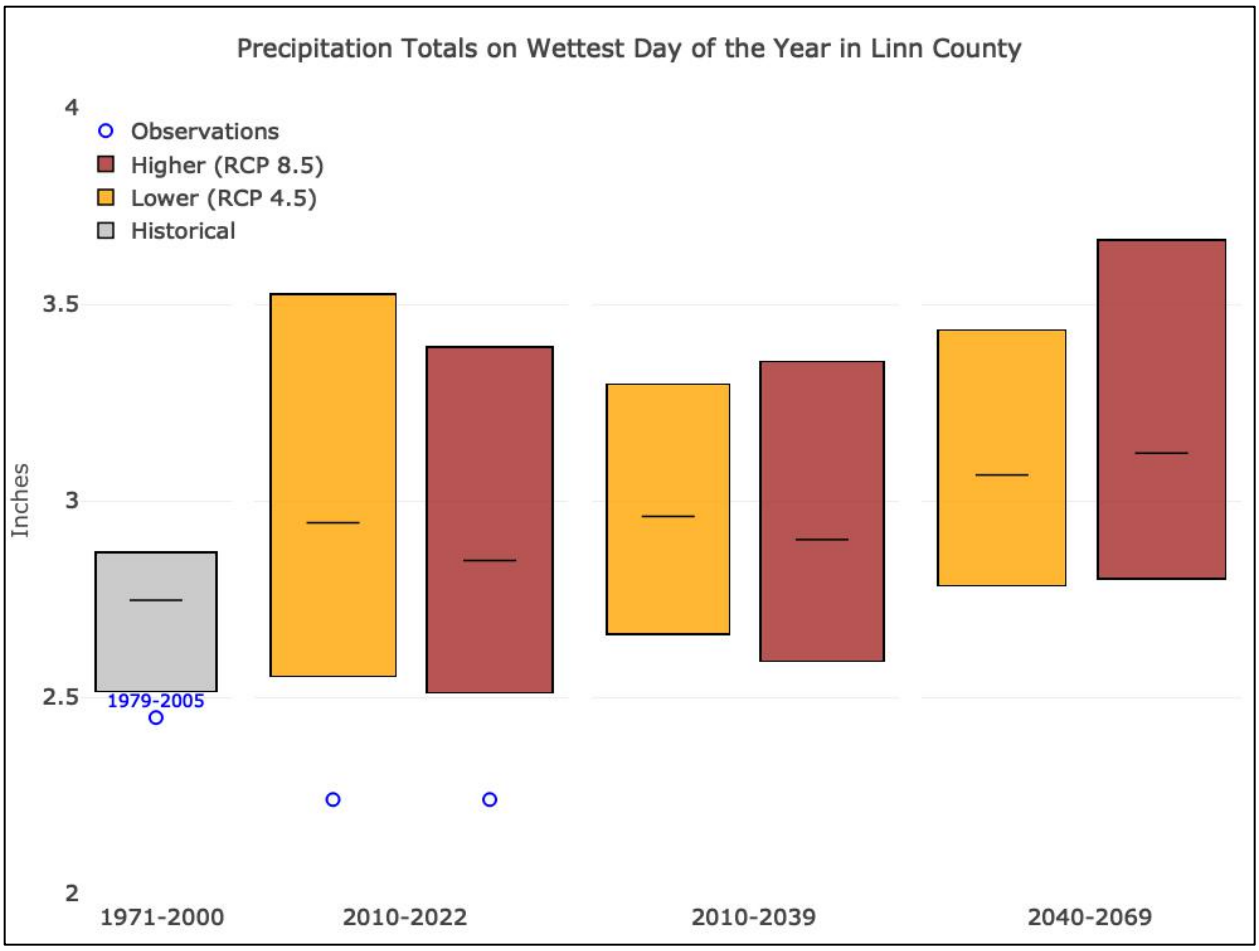

Figure 13. Projected amount of precipitation on the wettest day of the year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values.

The average observed amount of precipitation on the wettest consecutive five days of the year from 1979–2005, 5.30 inches, is 1.59 inches less than the model-simulated 1971–2000 average, 6.89 inches (Table 12, Figure 14). The average observed amount of precipitation on the wettest consecutive five days of the year from 2010–2022, 5.38 inches, was 1.76 inches less than the projected average under the higher emissions scenarios for the same time period (Figure 14). Again, the difference does not necessarily mean that the projections are unreliable. Our source of downscaled climate data projects greater increases in the frequency and magnitude of precipitation extremes than some other sources (Wang *et al.*, 2020a), but divergence in projected extremes among models is not unusual given that plausible future extreme values rarely are well represented in observational data. By the 2050s under the higher emissions scenario, the amount of precipitation on the wettest consecutive five days of the year is projected to change by -0.9–21.5% (Table 12). The average projected amount of precipitation on the wettest

consecutive five days is 9.6% above the average historical baseline of 6.9 inches. The amount of precipitation on the wettest consecutive five days of the year by the 2050s is projected to be between 6.52 and 8.82 inches depending on the model and emissions scenario (Figure 14).

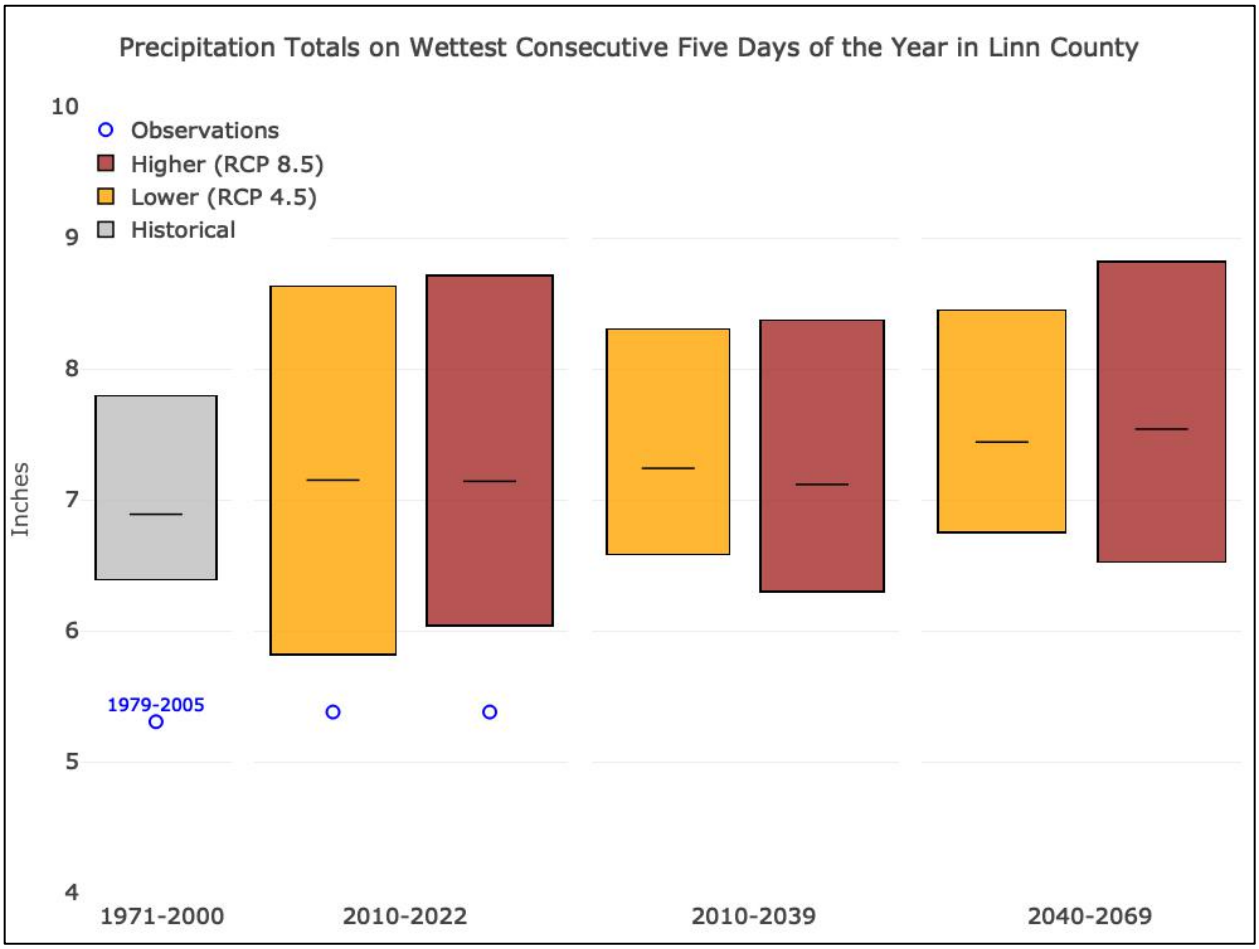

Figure 14. Projected amount of precipitation on the wettest consecutive five days of the year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values.

The average number of days per year on which precipitation exceeds 0.75 inches is not projected to change substantially (Figure 15). For example, by the 2050s under the higher emissions scenario, the number of wet days per year is projected to increase by 0.5 (range -4.5–3.7) (Table 12). The historical baseline is an average of 27 days per year. The average annual observed number of wet days was 21 from 1979 through 2005 and 20 from 2010 through 2022. Both of these observed averages are about seven days less than the average simulated historical baseline (Figure 15).

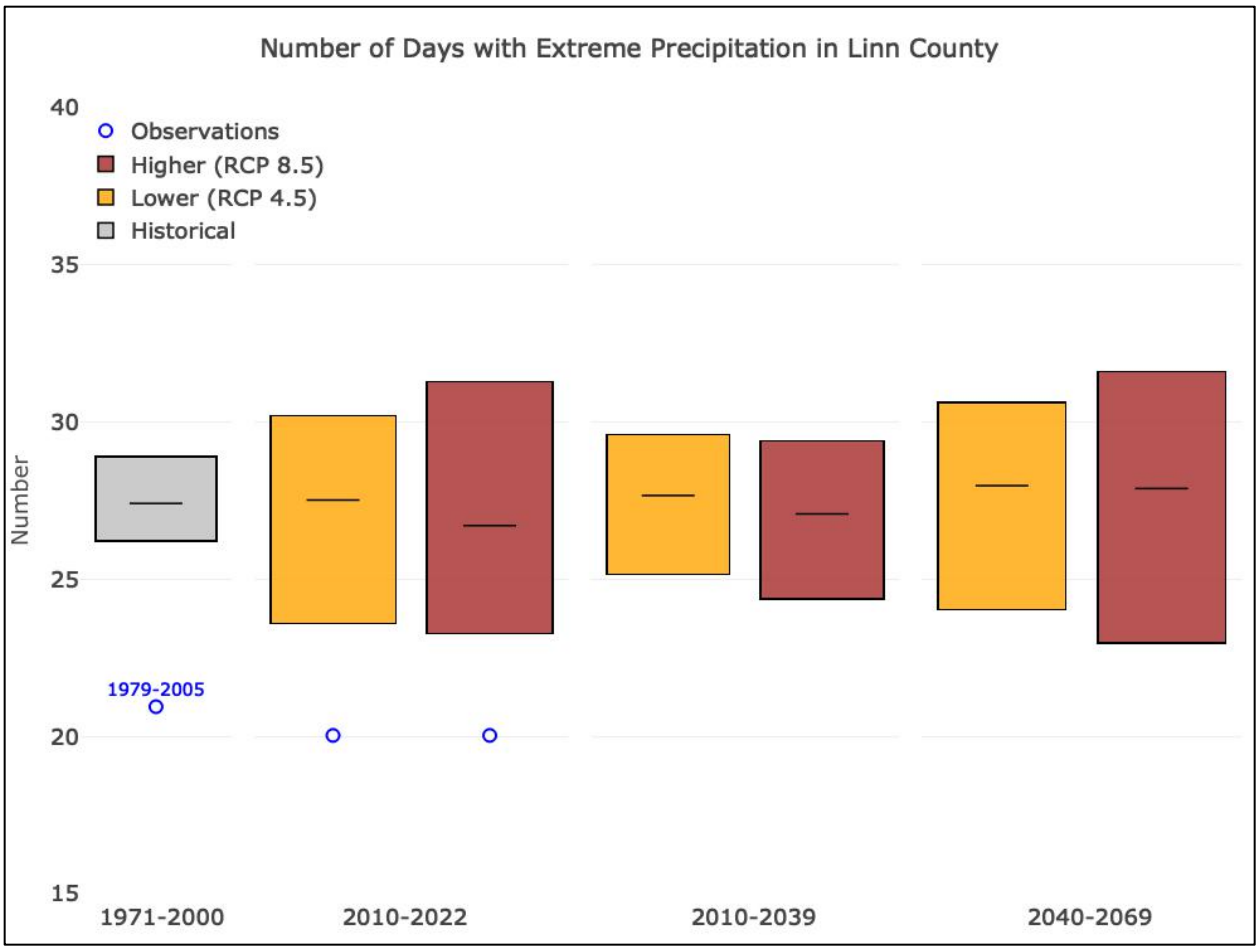

Figure 15. Projected number of wet days per year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values.

Landslides are often triggered by rainfall when the soil becomes saturated. As a surrogate measure of landslide risk, we present a threshold based on recent rainfall (cumulative precipitation over the previous 3 days) and antecedent precipitation (cumulative precipitation during the 15 days prior to the previous 3 days). The observed annual number of landslide risk days from 1979–2005, 29, is 2 days less than the model-simulated 1971–2000 average of 31 (Table 12, Figure 16). The observed annual number of landslide risk days from 2010–2022, 31, agrees well with the projected number under both emissions scenarios (Figure 16). By the 2050s under the higher emissions scenario, the average number of days per year in Linn County on which the landslide risk threshold is exceeded is projected to remain about the same, with a change of -0.5 (range -3.1–3.5) (Table 12). The historical baseline is an average of 31 days per year. Landslide risk depends on multiple site-specific factors, and this metric does not reflect all aspects of the hazard.

Also, the landslide risk threshold was developed for Seattle, Washington, and may be less applicable to other locations.

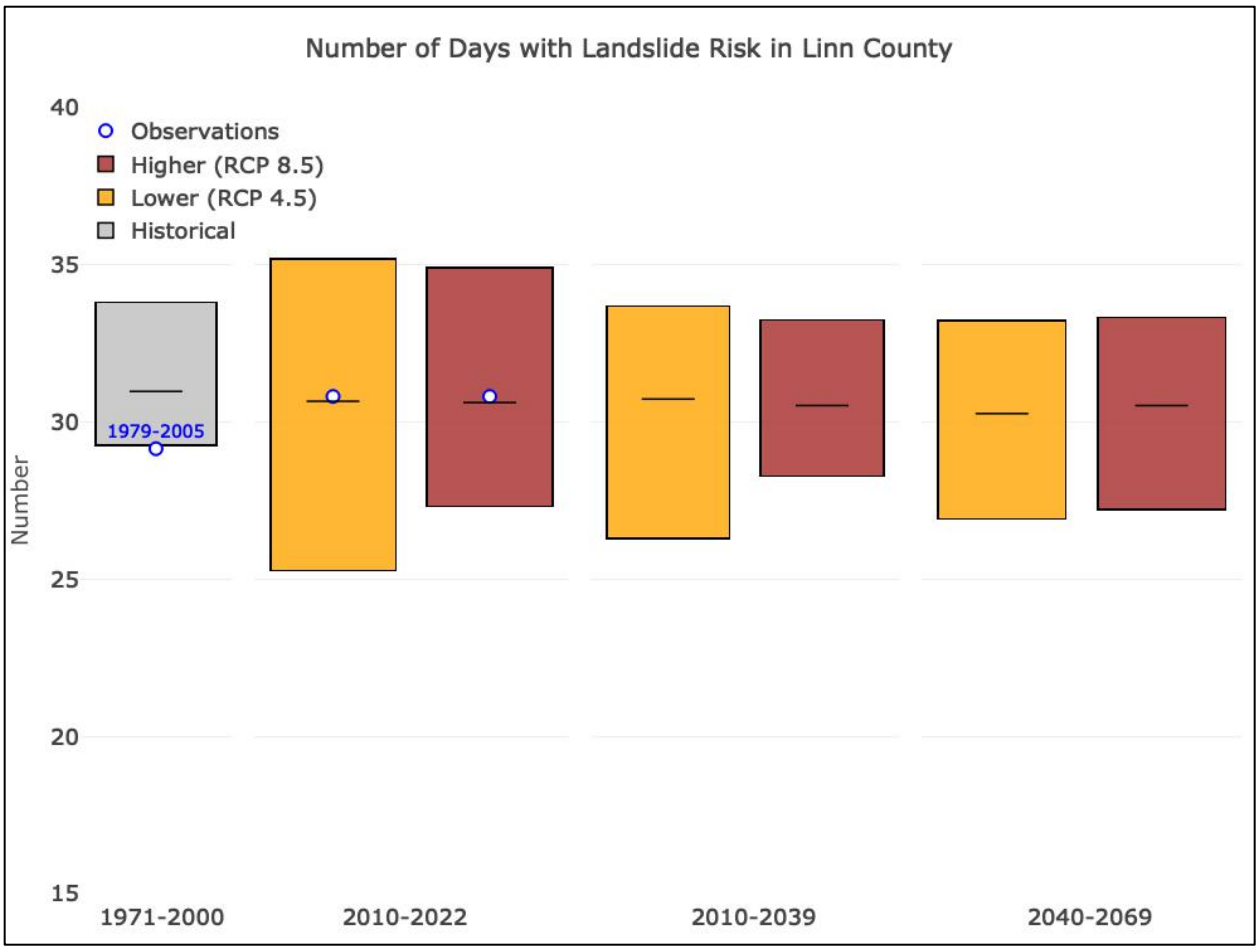

Figure 16. Projected number of landslide risk days per year in Linn County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. The bottoms and tops of the bars represent the minimum and maximum projected values across 20 global climate models, horizontal black lines represent the mean projected value, and blue circles represent the mean observed values.

Landslide risk also can become high when heavy rain falls on an area that burned within approximately the past five to ten years. The probability that extreme rainfall will occur within one year after an extreme fire-weather event in Oregon or Washington was projected to increase by 700% from the period 1980–2005 to 2100 under the higher emissions scenario (Touma *et al.*, 2022). Similarly, projections suggest that by 2100, 90% of extreme fire-weather events across Oregon and Washington are likely to be succeeded within five years by three or more extreme rainfall events (Touma *et al.*, 2022). Although fire weather is not synonymous with wildfire, these results highlight the increasing likelihood of compounded climate extremes that elevate the risk of natural hazards.

Populations considered particularly vulnerable to the direct and indirect effects of extreme precipitation, from the storms themselves to floods and landslides, include people dependent on medical equipment that requires electricity, older adults, children, and pregnant people (York *et al.*, 2020; Ho *et al.*, 2021). Recent and projected estimates of populations that are older, younger, and of childbearing age are included in previous sections. Some utility companies provide consultation and additional outreach to individuals who are dependent on electricity for a medical device. Among the diverse health risks associated with extreme precipitation are injuries, toxic exposures, displacement, disruptions in medical care, and negative mental health outcomes (York *et al.*, 2020; Ho *et al.*, 2021).

Summary

The intensity of extreme precipitation is expected to increase as the atmosphere warms and holds more water vapor. In Linn County, the number of days per year with at least 0.75 inches of precipitation is not projected to change substantially. Nevertheless, by the 2050s, the amount of precipitation on the wettest day and wettest consecutive five days per year is projected to increase by an average of 14% (range -1–35%) and 10% (range -1–22%), respectively, relative to the 1971–2000 historical baseline, under the higher emissions scenario. The number of days per year on which a threshold for landslide risk, which is based on prior 18-day precipitation accumulation, is exceeded is not projected to change substantially. However, landslide risk depends on multiple factors, and this metric does not reflect all aspects of the hazard.

River Flooding

Streams in the Northwest are projected to shift toward higher winter runoff, lower summer and fall runoff, and earlier peak runoff, particularly in snow-dominated regions (Raymondi *et al.*, 2013; Naz *et al.*, 2016). These changes are expected as a result of increases in the intensity of heavy precipitation; warmer temperatures that cause more precipitation to fall as rain and less as snow, and snow to melt earlier in spring; and increasing winter precipitation and decreasing summer precipitation (Dalton *et al.*, 2017, 2021; Mote *et al.*, 2019).

Warming temperatures and increasing winter precipitation are expected to increase flood risk in many basins in the Northwest, particularly mid- to low-elevation, mixed rain-and-snow basins in which winter temperatures are near freezing (Tohver *et al.*, 2014). The greatest projected changes in peak streamflow magnitudes are at intermediate elevations in the Cascade Range and Blue Mountains (Safeeq *et al.*, 2015). Regional hydroclimate models project increases in extreme high flows throughout most of the Northwest, especially west of the Cascade crest (Salathé *et al.*, 2014; Najafi and Moradkhani, 2015; Naz *et al.*, 2016). One study that used a single climate model projected an increase in flood risk in fall due to earlier, more extreme storms, including atmospheric rivers; and an increase in the proportion of precipitation falling as rain rather than snow (Salathé *et al.*, 2014). Rainfall-driven floods are more sensitive to increases in precipitation than snowmelt-driven floods. Therefore, the projected increases in total precipitation, and in rain relative to snow, likely will increase flood magnitudes in the region (Chegwidden *et al.*, 2020).

The Santiam River at Detroit Dam (Figure 17), the Middle Fork Santiam River at Green Peter Reservoir (Figure 18), and the South Santiam River at Foster Reservoir (Figure 19) are within mixed rain-and-snow basins in which flow peaks during winter and, to a lesser degree, during spring snowmelt. By the 2050s (2040–2069), under both emissions scenarios, streamflow is projected to shift as the basins become rain-dominated and the snowpack melts earlier as temperatures increase. Winter streamflow is projected to increase due to increased winter precipitation and a greater percentage of precipitation falling as rain rather than snow. Mean monthly flows do not translate directly to flood risk because floods occur over shorter periods of time. However, increases in monthly flow may imply increases in flood likelihood, particularly if increases are projected to occur during months in which flood occurrence historically has been high.

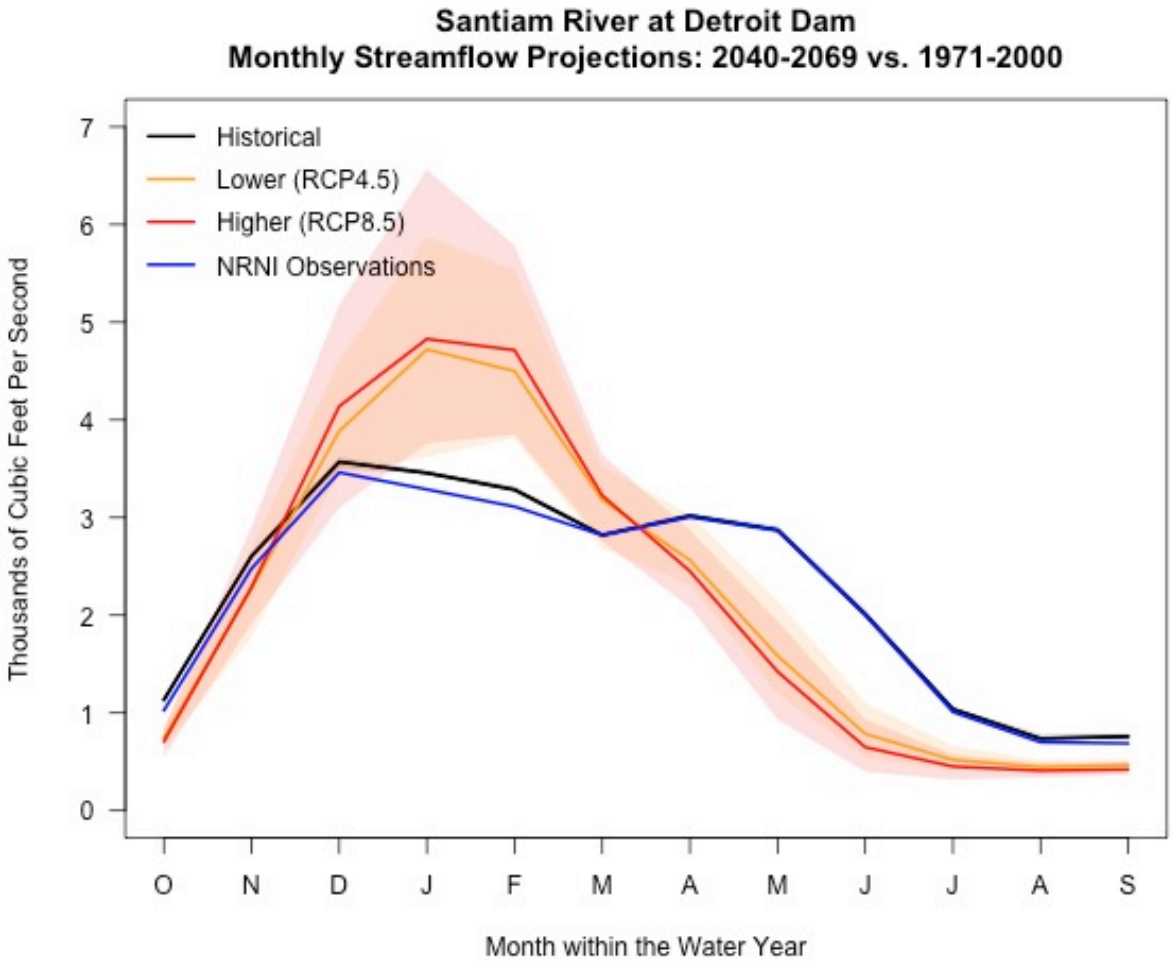

Figure 17. Simulated monthly, bias-corrected, non-regulated streamflow at the Santiam River at Detroit Dam from 2040–2069 compared to 1971–2000. Solid lines and shading represent the mean and range across ten global climate models. (Data source: Integrated Scenarios of the Future Northwest Environment, climatetoolbox.org/tool/future-streamflows; NRNI: non-regulated, non-irrigated flow [estimated effects of regulation and irrigation withdrawals removed] from www.bpa.gov/energy-and-services/power/historical-streamflow-data.)

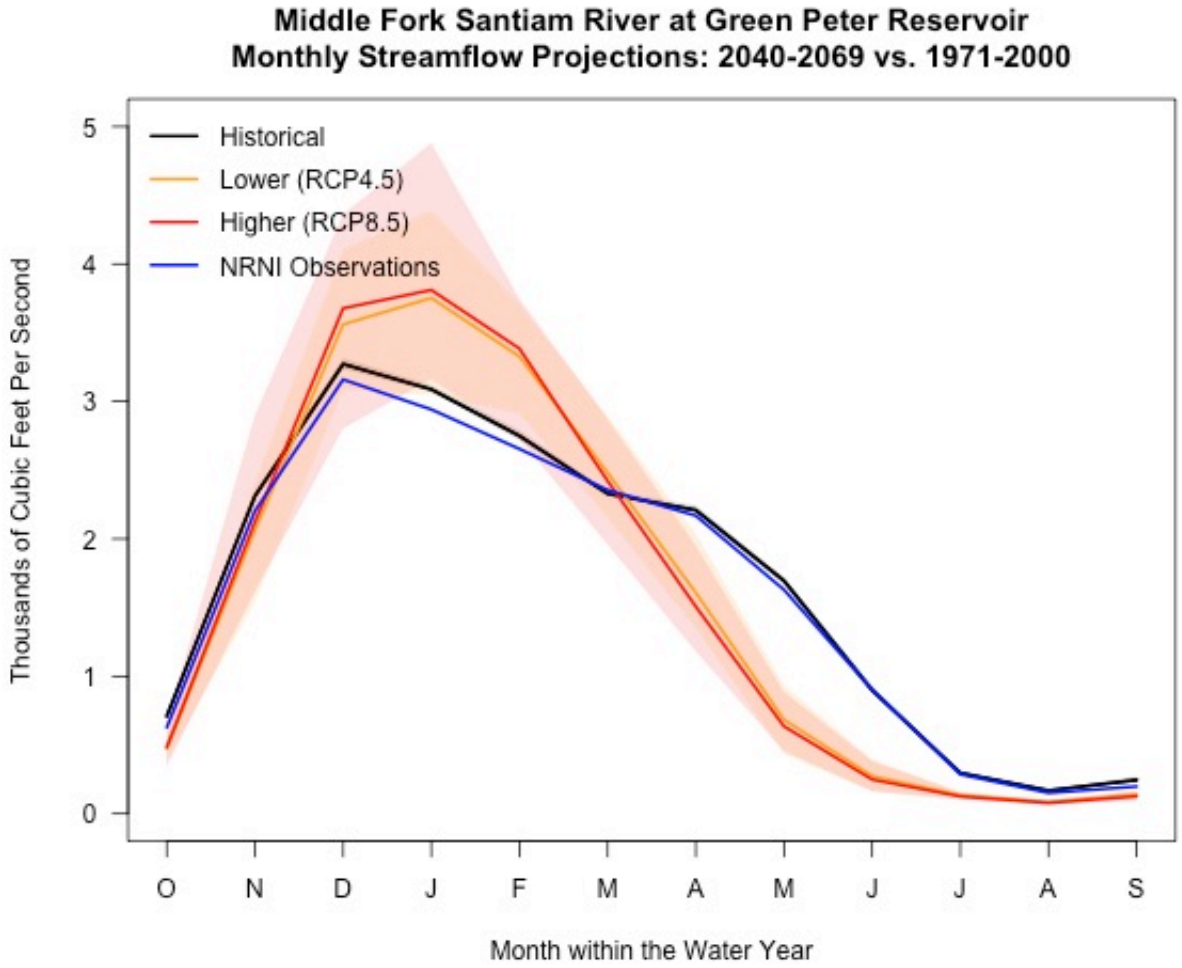

Figure 18. Simulated monthly, bias-corrected, non-regulated streamflow at the Middle Fork Santiam River at Green Peter Reservoir from 2040–2069 compared to 1971–2000. Solid lines and shading represent the mean and range across ten global climate models. (Data source: Integrated Scenarios of the Future Northwest Environment, climatetoolbox.org/tool/future-streamflows; NRNI: non-regulated, non-irrigated flow [estimated effects of regulation and irrigation withdrawals removed] from www.bpa.gov/energy-and-services/power/historical-streamflow-data.)

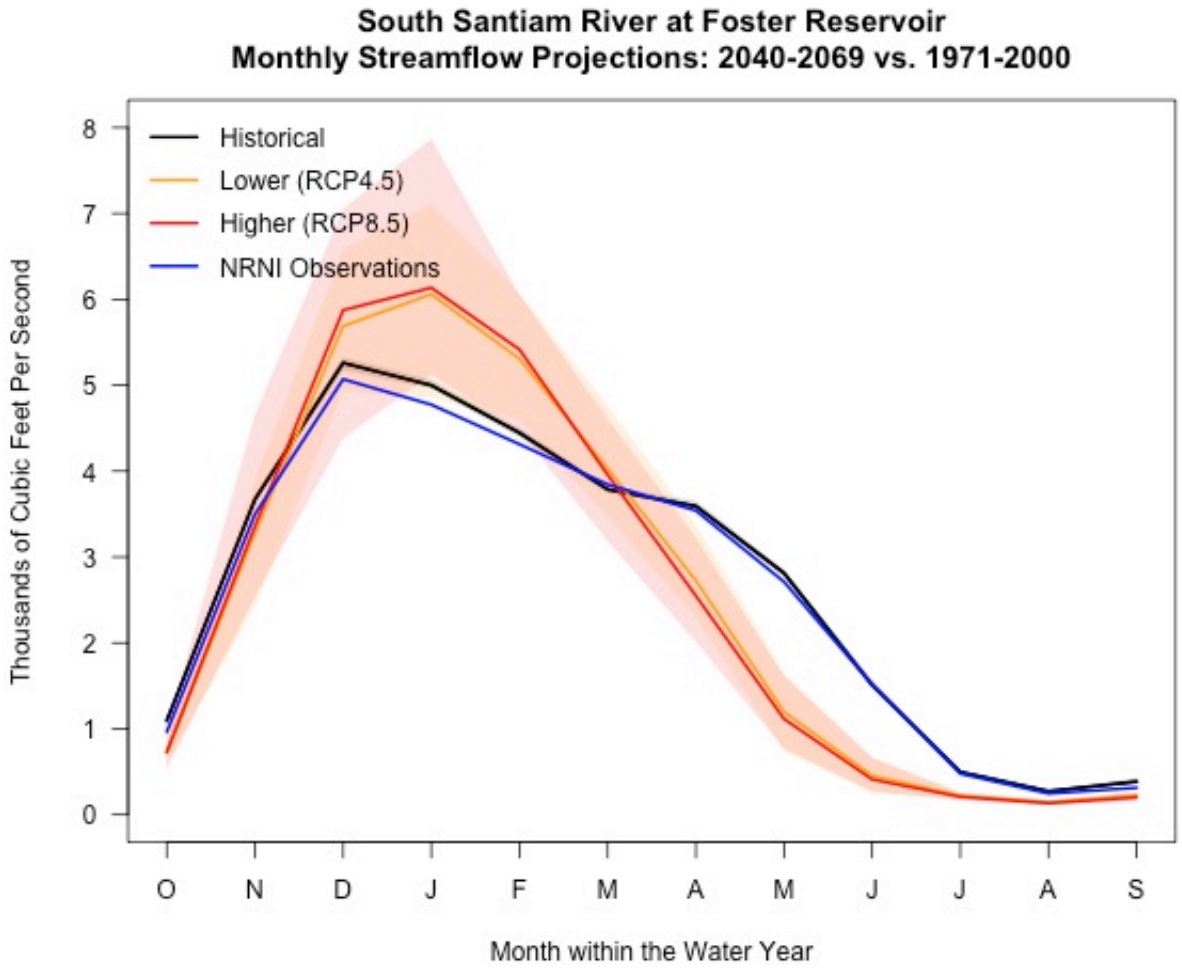

Figure 19. Simulated monthly, bias-corrected, non-regulated streamflow at the South Santiam River at Foster Reservoir from 2040–2069 compared to 1971–2000. Solid lines and shading represent the mean and range across ten global climate models. (Data source: Integrated Scenarios of the Future Northwest Environment, climatetoolbox.org/tool/future-streamflows; NRNI: non-regulated, non-irrigated flow [estimated effects of regulation and irrigation withdrawals removed] from www.bpa.gov/energy-and-services/power/historical-streamflow-data.)

Across the western United States, the average magnitudes of major floods are projected to increase by 14–19% by 2010–2039, 21–30% by 2040–2069, and 31–43% by 2070–2099, compared to the 1971–2000 historical baseline, under the higher emissions scenario (Maurer *et al.*, 2018). Major floods are defined as daily peak flow magnitudes that are associated with 100-year to 10-year return periods (1–10% probability that this daily flow magnitude will be exceeded in a given year).

We estimated projected changes in the average magnitude of single-day flood levels with 2-year, 10-year, and 25-year return periods (50%, 10%, and 4% probability, respectively, that this daily flow magnitude will be exceeded in a given year) for three locations in Linn County (Table 13). We then compared flood magnitudes between 1961–2010 and 2031–2080.

Table 13. Percent change in peak flow associated with multiple return periods for three locations in Linn County by 2031–2080, relative to 1961–2010, under the higher emissions scenario.

Return Period (Probability that this level will be exceeded in a given year)	Average Percent Change in Flow		
	Santiam River at Detroit Dam	Middle Fork Santiam River at Green Peter Reservoir	South Santiam River at Foster Reservoir
2-year (50%)	11.2	3.7	2.5
10-year (10%)	9.4	5.0	5.2
25-year (4%)	8.9	11.7	11.0

On the Santiam River at Detroit Dam, the average magnitudes of single-day floods with 2-year, 10-year, and 25-year return periods were projected to increase by 11%, 9%, and 9%, respectively, by the 2050s, compared to 1961–2010, under the higher emissions scenario (Figure 20, Table 13). On the Middle Fork Santiam River at Green Peter Reservoir, the average magnitudes of single-day floods with 2-year, 10-year, and 25-year return periods were projected to increase by 4%, 5%, and 12%, respectively, by the 2050s, compared to 1961–2010, under the higher emissions scenario (Figure 21, Table 13). On the South Santiam River at Foster Reservoir, the average magnitudes of single-day floods with 2-year, 10-year, and 25-year return periods were projected to increase by 3%, 5%, and 11%, respectively, by the 2050s, compared to 1961–2010, under the higher emissions scenario (Figure 22, Table 13). Some models projected no change or decreases in the magnitude of maximum daily flows for each return period. These results can be interpreted as either an increase in flood magnitude given a flood frequency, or an increase in flood frequency given a flood magnitude. These analyses were exploratory and should not be applied to engineering or design.

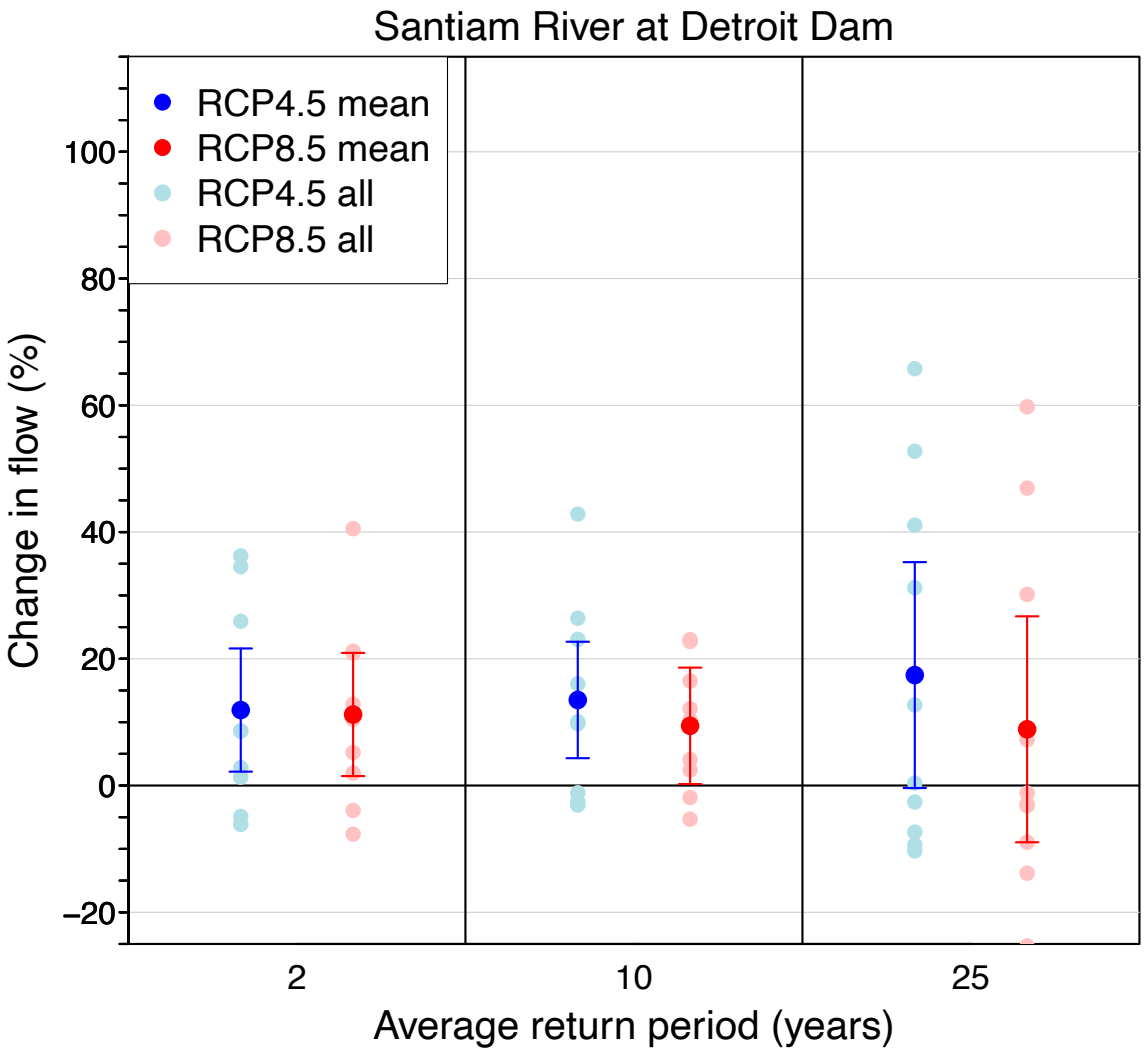

Figure 20. Projected change in water-year maximum daily, non-regulated streamflows with 2-year, 10-year, and 25-year return periods along the Santiam River at Detroit Dam from 1961–2010 to 2031–2080 under lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios. Larger blue and red dots and bars represent the mean and two standard errors across ten global climate models. Only ten of the full set of 20 models that were used to project temperature and precipitation simulated future hydrology (see *Appendix*). Smaller light blue and light red dots represent projections from individual models. (Data source: Integrated Scenarios of the Future Northwest Environment, climate.northwestknowledge.net/IntegratedScenarios)

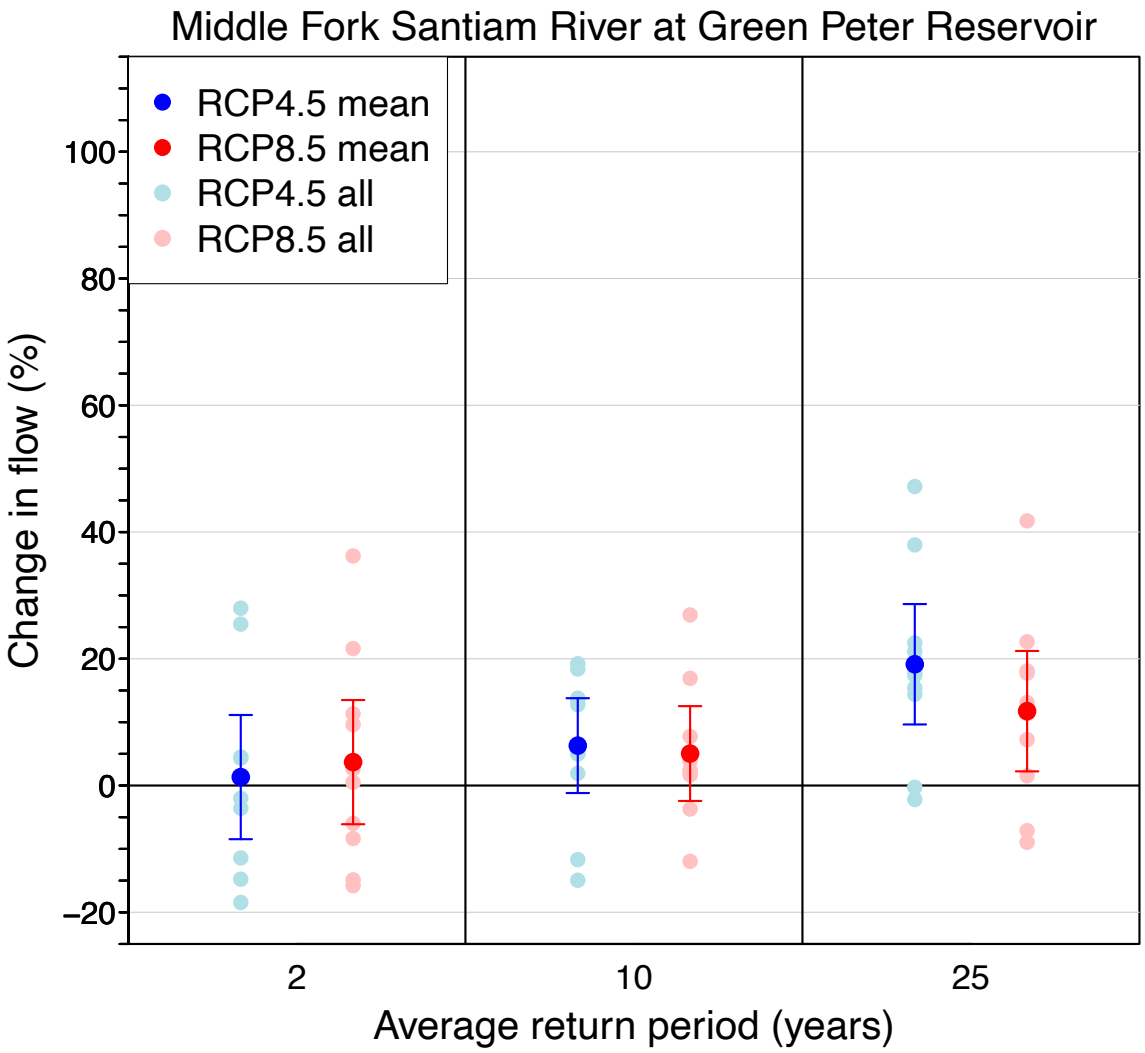

Figure 21. Projected change in water-year maximum daily, non-regulated streamflows with 2-year, 10-year, and 25-year return periods along the Middle Fork Santiam River at Green Peter Reservoir from 1961–2010 to 2031–2080 under lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios. Larger blue and red dots and bars represent the mean and two standard errors across ten global climate models. Only ten of the full set of 20 models that were used to project temperature and precipitation simulated future hydrology (see *Appendix*). Smaller light blue and light red dots represent projections from individual models. (Data source: Integrated Scenarios of the Future Northwest Environment, climate.northwestknowledge.net/IntegratedScenarios)

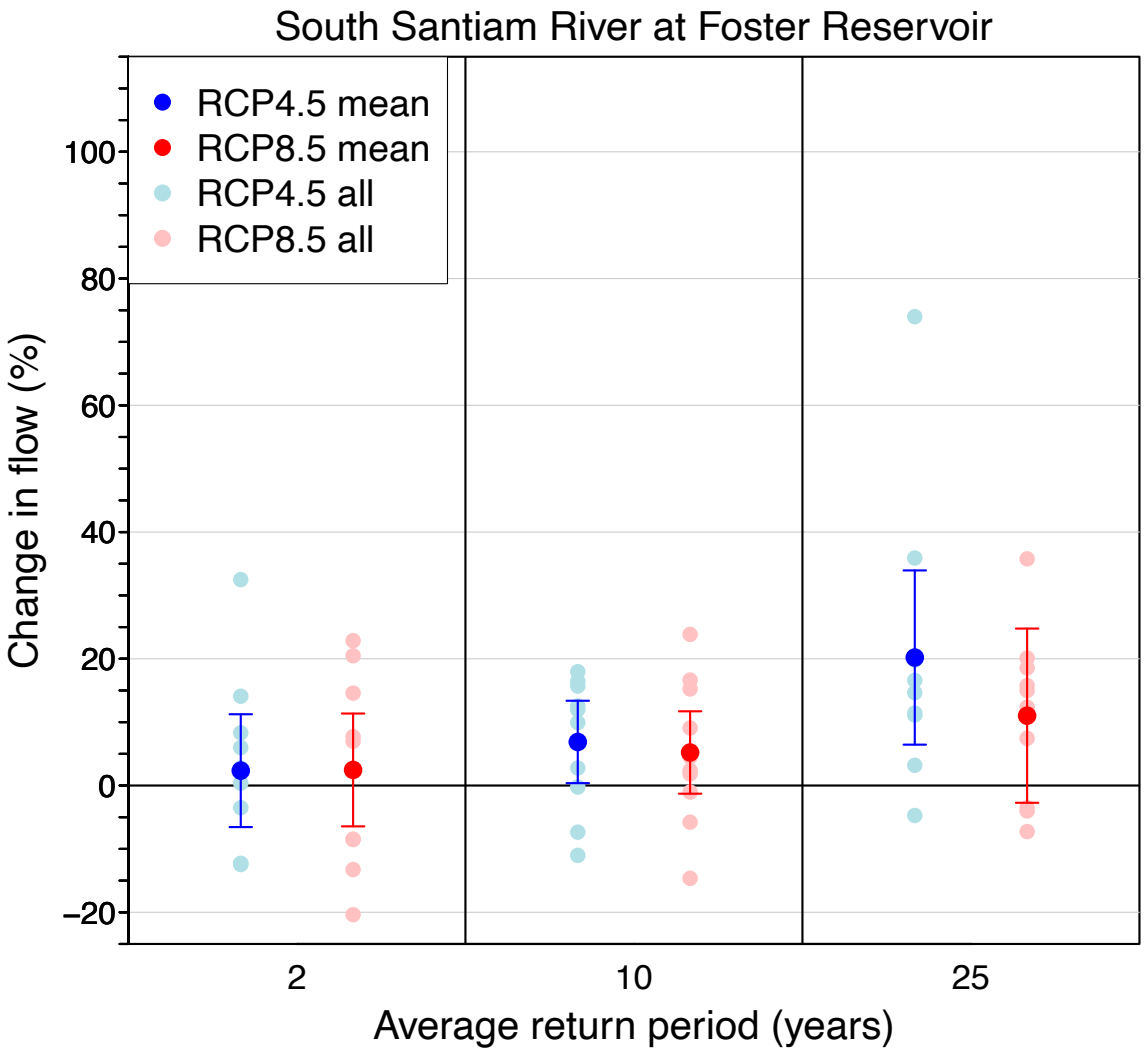

Figure 22. Projected change in water-year maximum daily, non-regulated streamflows with 2-year, 10-year, and 25-year return periods along the South Santiam River at Foster Reservoir from 1961–2010 to 2031–2080 under lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios. Larger blue and red dots and bars represent the mean and two standard errors across ten global climate models. Only ten of the full set of 20 models that were used to project temperature and precipitation simulated future hydrology (see *Appendix*). Smaller light blue and light red dots represent projections from individual models. (Data source: Integrated Scenarios of the Future Northwest Environment, climate.northwestknowledge.net/IntegratedScenarios)

Some of the Northwest's highest floods occur when large volumes of warm rain from atmospheric rivers fall on a deep snowpack (Safeeq *et al.*, 2015). The frequency and amount of moisture transported by atmospheric rivers is projected to increase along the West Coast in response to increases in air temperature (Kossin *et al.*, 2017), which in turn increases the likelihood of flooding (Konrad and Dettinger, 2017).

Future changes in the frequency of rain-on-snow events likely will vary along elevational gradients. At lower elevations, the frequency is projected to decrease due to decreasing snowpack, whereas at higher elevations the frequency is projected to increase due to the shift from snow to rain (Surfleet and Tullos, 2013; Safeeq *et al.*, 2015; Musselman *et al.*, 2018). The likely effects on streamflow of such changes in frequency of rain-on-snow events vary. For example, projections for the Santiam River, Oregon, indicated an increase in annual peak daily flows with return intervals less than 10 years, but a decrease in annual peak daily flows with return intervals of 10 or more years (Surfleet and Tullos, 2013). Average runoff from rain-on-snow events in watersheds in western Oregon and the mid-Columbia River basin was projected to decline due to depletion of the snowpack (Musselman *et al.*, 2018), which may imply that the driver of floods in these areas shifts from rain-on-snow events to rainfall that exceeds soil capacity (Berghuijs *et al.*, 2016; Musselman *et al.*, 2018). Wildfires and shifts in vegetation that affect soil properties also will likely affect water transport, but hydrological models generally have not accounted for these processes (Bai *et al.*, 2018; Wang *et al.*, 2020b; Williams *et al.*, 2022).

Potential Effects of Projected Flooding on Infrastructure

First Street Foundation (2023) estimated that 10,956 properties in Linn County (33%) have a >26% probability of being severely affected by flooding by 2053. Severe flooding corresponds to a 1-in-100 year flood, or a flood with a 1% probability of occurring in a given year, and such an event has a 26% probability of occurring one or more times during a 30-year mortgage period. Among the structures that may be affected by flooding are 12,593 residences (32%), 1121 commercial properties (44%), 27 critical infrastructure facilities (e.g., hospitals; police, fire, and power stations; and water treatment facilities) (37%), and 69 (35%) social facilities (schools, houses of worship, museums, and government or historic buildings) at moderate risk (Table 14). Of the 6812 miles of roads in Linn County, 2124 (31%) were estimated to be at severe risk of flooding (First Street Foundation, 2023).

Table 14. 30-year cumulative probability of flooding to different depths by 2053 and First Street Foundation's associated risk characterizations.

		30-year cumulative probability					
		≤0.06	>0.06–0.12	>0.12–0.27	>0.27–0.47	>0.47–0.96	>0.96
Flood depth	0–3”	Low	Moderate	Moderate	Major	Major	Severe
	>3–6”	Low	Moderate	Moderate	Major	Major	Severe
	>6–9”	Moderate	Moderate	Major	Major	Severe	Extreme
	>9–12”	Moderate	Moderate	Major	Severe	Severe	Extreme
	>12–24”	Moderate	Major	Major	Severe	Extreme	Extreme
	>24”	Major	Major	Severe	Extreme	Extreme	Extreme

Summary

Winter flood risk at intermediate to low elevations in Linn County, where temperatures are near freezing during winter and precipitation is a mix of rain and snow, is projected to increase as winter temperatures increase. The temperature increase will lead to an increase in the percentage of precipitation falling as rain rather than snow.

Drought

Drought can be defined in many ways (Table 15), but most fundamentally is insufficient water to meet needs (Redmond, 2002; O'Neill *et al.*, 2021; O'Neill and Siler, 2023). Summer drought is common in the Northwest, particularly because seasonal precipitation is lowest during the warmest season (O'Neill and Siler, 2023). The incidence, extent, and severity of drought increased over the last 20 years relative to the twentieth century, and this trend is expected to continue (O'Neill *et al.*, 2021; O'Neill and Siler, 2023).

Table 15. Definitions and characteristics of various drought classes. (Sources: O'Neill *et al.*, 2021; O'Neill and Siler, 2023; Fleishman *et al.*, unpublished)

Drought Class	Definition and Characteristics
Meteorological	• lack of precipitation • evaporative demand that exceeds precipitation for 90 days or longer
Hydrological	• extended periods of meteorological drought that affect surface or subsurface water supply, such as streamflow, reservoir and lake levels, or ground water levels • tends to evolve more slowly than meteorological drought and to persist for longer than six months
Agricultural	• occurs when lack of surface or subsurface water adversely affects agricultural production • reflects precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, and reduced availability of water for irrigation
Socioeconomic	• occurs when meteorological, hydrological, or agricultural drought reduces the supply of an economic or social good or service • often affects issuance of state and federal drought declarations
Ecological	• undesirable changes in ecological state caused by deficits in water availability • usually caused by meteorological or hydrological drought • sensitivity to water limitation varies among species and life stages
Flash	• rapid-onset period of elevated surface temperature, low relative humidity, precipitation deficit, and a rapid decline in soil moisture • tends to develop and intensify rapidly within a few weeks, and may be generated or magnified by prolonged heat waves
Snow	• snowpack—or snow water equivalent (SWE)—is below average for a given point in the water year, traditionally 1 April • often presages hydrological drought during the ensuing spring and summer in snowmelt-dominated watersheds • warm snow drought refers to below-average snowpack that results primarily from above-average winter temperatures • dry snow drought refers to below-average snowpack that results primarily from below-average winter precipitation

Drought often affects human health both through respiratory mortality (Gwon *et al.*, 2023) and less directly, such as through food scarcity and the increased incidence of infectious, chronic, and vector-borne diseases. Moreover, drought affects both physical and mental health (Vins *et al.*, 2015). Low income, tribal, rural, and farming and farmworker communities are especially susceptible to negative health effects as a result of drought and associated water scarcity and poor water quality (York *et al.*, 2020; Ho *et al.*, 2021). Recent and projected estimates of low income, rural, and some farmworker populations are presented in previous sections.

No precipitation trends in Linn County over the period of record (1895–2023) are apparent (NCEI, 2023). Nevertheless, by 2100, annual mean precipitation in Oregon is projected to increase by 5–10% (O'Neill and Siler, 2023), with most of the precipitation falling during winter. Summers in the state are expected to become drier and warmer (Dalton *et al.*, 2021; Fleishman, 2023). Summers (June, July, and August) in Linn County warmed at a rate of 2.1°F per century from 1895 through 2022, faster than annual average temperature (1.7°F per century) (NCEI, 2023). Winters (December, January, and February) warmed at a rate of 1.9°F per century over the same period (NCEI, 2023). As winters continue to warm, snowpack across Oregon is projected to decline by approximately 25% by 2050 relative to 1950–2000 (Siirila-Woodburn *et al.*, 2021). Snowpack averaged over the western United States declined by 21% from 1915 through 2014 (Mote *et al.*, 2018). The decline in snowpack is projected to reduce summer soil moisture in the mountains (Gergel *et al.*, 2017). Climate change is also expected to reduce summer streamflows in snow-dominated and mixed rain and snow basins across the Northwest as snowpack melts earlier and summer precipitation decreases (Dalton *et al.*, 2017; Mote *et al.*, 2019). For example, summer flow is projected to decrease in the Santiam River by the 2050s (Figures 17–19). As mountain snowpack declines, seasonal drought will become less predictable and snow droughts will increase the likelihood of hydrological and agricultural drought during the following spring and summer (Dalton and Fleishman, 2021; Fleishman, 2023).

We present projected changes in four variables indicative of drought: low spring (April 1) snowpack (snow drought), low summer (June–August) soil moisture from the surface to 55 inches below the surface (agricultural drought), low summer runoff (hydrological drought), and low summer precipitation (meteorological drought). We present drought in terms of a change in the probability of exceeding the magnitude of seasonal conditions for which the historical annual probability of exceedance was 20% (5-year return period) (Figure 23).

Summer soil moisture, spring snowpack, summer runoff, and summer precipitation in Linn County are projected to decline by the 2050s under both lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios. Therefore, seasonal drought will occur more frequently by the 2050s (Figure 23). By the 2050s under the higher emissions scenario, the annual probability of low summer soil moisture is projected to be about 51% (2-year return period). The annual probabilities of low spring snowpack, low summer runoff, and low summer precipitation are projected to be about 69% (1.5-year return period), 75% (1.3-year return period), and 32% (3.1-year return interval), respectively.

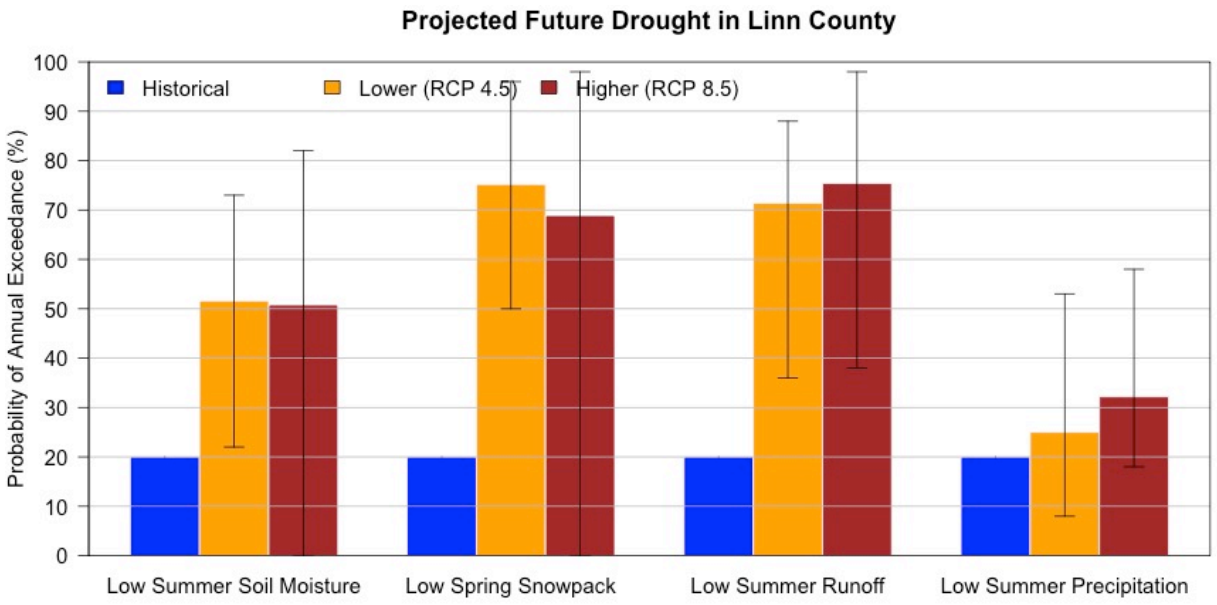

Figure 23. Projected probability of exceeding the magnitude of seasonal drought conditions for which the historical annual probability of exceedance was 20%. Projections are for the 2050s (2040–2069), relative to the historical baseline (1971–2000), under two emissions scenarios. Seasonal drought conditions include low summer soil moisture (average from June through August), low spring snowpack (April 1 snow water equivalent), low summer runoff (total from June through August), and low summer precipitation (total from June through August). The bars and whiskers represent the mean and range across ten global climate models. (Data source: Integrated Scenarios of the Future Northwest Environment, climate.northwestknowledge.net/IntegratedScenarios)

Summary

Drought, as represented by low spring snowpack, low summer precipitation, low summer soil moisture, and low summer runoff, is projected to become more frequent in Linn County by the 2050s. The incidence of related negative physical and mental health outcomes, especially among low income, tribal, rural, and agricultural communities, is likely to increase.

Wildfire

Projection of contemporary wildfire risk requires an understanding of interactions among plant physiology, climate, and human activities.

Aridity, Heat, Insects, and Wildfire Risk

Drought across the western United States has been exacerbated by warmer winters and springs, which drive an overall decline in mountain snowpack and earlier snowmelt (Westerling, 2016), and by longer summers. Extreme heat in June 2021 (Heeter *et al.*, 2023) caused mortality of seedlings and saplings in plantations while scorching the canopy of mature trees (Still *et al.*, 2023). High temperatures are a major contributor to desiccation of dead vegetation, whereas dry air reduces moisture in live vegetation. The drier the air, the more plants transpire and lose water. If tall trees cannot draw enough water from the soil, they may be at risk of embolism (Olson *et al.*, 2018; Anfodillo and Olson, 2021) and more likely to die. Dry dead or living vegetation is more likely to burn than wet vegetation. Because concurrent heat and drought are becoming more common (Alizadeh *et al.*, 2020), the volume of stressed or dead vegetation and wildfire risk are increasing.

Trees that become drought-stressed generally are more vulnerable to outbreaks of native and non-native insects and pathogens that can lead to the trees' death. For example, densities of mountain pine beetles (*Dendroctonus ponderosae*), which are native to eastern Oregon, generally are low, but eruptions can result in 60% stand-level mortality over tens to hundreds of square miles (Abrams *et al.*, 2021). The insects primarily feed on lodgepole, ponderosa, western white, sugar, and whitebark pine (*Pinus contorta*, *ponderosa*, *monticola*, *lambertiana*, and *albicaulis*). Mountain pine beetles carry fungi that can hasten tree death, especially during a drought, by disrupting water transport. The beetles usually have one generation per year but may be able to reproduce twice per year as temperatures increase.

Western spruce budworm (*Choristoneura freemani*) and Douglas-fir tussock moth (*Orgyia pseudotsugata*) are moths native to Oregon. They feed on the foliage of Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), white fir (*Abies concolor*), Englemann spruce (*Picea engelmannii*), and other conifers, reducing tree growth and increasing the trees' susceptibility to other insects and pathogens and the likelihood of mortality (Flower *et al.*, 2014). In 1991, for example, 6250 square miles were defoliated by the budworm (Oester *et al.*, 1992). The effects of these insects on trees generally are greatest during hot, dry summers.

Vegetation dryness is often caused by dry air. The dryness of the air, also called evaporative demand, is characterized by the vapor pressure deficit (VPD). The VPD is the difference in atmospheric pressure between the current amount of water vapor in the air and the maximum amount of water the air can hold at a given temperature (dew point). VPD is increasing globally, and CMIP6 climate models indicate that human emissions of greenhouse gases explained 68% of the observed VPD increase from 1979 through 2020 (Zhuang *et al.*, 2021). These models also project that across the western United States, given a higher emissions scenario, warm season VPD over the next 30 years will increase at a rate similar to that observed from 1979 through 2020 (Zhuang *et al.*, 2021). Area burned is more strongly correlated with VPD than with other drought indices or variables, such as

temperature and precipitation (Sedano and Randerson, 2014; Williams *et al.*, 2014; Seager *et al.*, 2015; Rao *et al.*, 2022). CMIP5 models projected that increases in VPD will contribute substantially to wildfire risk in Oregon (Ficklin and Novick, 2017; Chiodi *et al.*, 2021) and across the West (Abatzoglou *et al.*, 2021a; Zhuang *et al.*, 2021; Juang *et al.*, 2022).

From 1985 through 2017, the annual area burned by high-severity fires across forests in the western United States increased eightfold (Parks and Abatzoglou, 2020). However, area burned did not increase in naturally cool rainforests on the west side of the Cascade Range. Historically, wildfires in these rainforests occurred every few centuries due to the lack of ignitions and moist vegetation. The frequency of large wildfires in forests has also increased: such fires now occur nearly every year in the Northwest (Rupp and Holz, 2023). About half of the observed increase in vegetation dryness in the western United States from 1984 through 2015—again, driven mainly by the dryness of the air—and 16,000 square miles of burned area were attributable to human-caused climate change (Abatzoglou and Williams, 2016).

Historically, wildfires were less active overnight, and the probability of fire expansion generally was evaluated on the basis of daytime conditions. However, across the western United States, the number of nights during which atmospheric conditions are conducive to burning has increased by 45% since 1979 (Balch *et al.*, 2022). The intensity and duration of wildfires is expected to increase as nights continue to become hotter and drier (Chiodi *et al.*, 2021; Balch *et al.*, 2022).

Land Use and Wildfire Risk

Projections that include concurrent increases in aridity, temperature, and intensification of land use (which leads to an increase in human ignitions; see below) indicate that area burned and the frequency of wildfires will continue to increase in the Pacific Northwest, and wildfire intensity will increase (Sheehan *et al.*, 2015; Dalton *et al.*, 2017; Mote *et al.*, 2019; Dalton and Fleishman, 2021; Rupp and Holz, 2023). The probability of wildfire occurrence in the Cascade Range of Oregon as a function of temperature and precipitation is projected to increase by 63% under the lower emissions scenario (RCP 4.5) and 122% under the higher emissions scenario (RCP 8.5) (Gao *et al.*, 2021). Under the lower emissions scenario, the average annual area burned in Oregon's forests is expected to increase by at least 50% over the next several decades (Rupp and Holz, 2023). In addition, a 3.6°F increase above the average annual temperature from 2002–2020 was projected to double the annual number of extreme, single-day spreading wildfires in the western United States (Coop *et al.*, 2022). The interactions among housing development, the growth of tourism in forested areas, and increasing atmospheric dryness suggest that past projections of changing wildfire risk in the West may be underestimates (Rao *et al.*, 2022).

Extreme wildfires often occur when vegetation is dry and weather conditions conducive to fire, including high temperatures, aridity, and wind speeds (Reilly *et al.*, 2022), coincide. Coincidence among these extremes is becoming more common (Abatzoglou *et al.*, 2021a). These fires can cause widespread loss of structures and the loss of human lives (Abatzoglou *et al.*, 2021b). The 2020 Labor Day fires in the western Cascade Range (Higuera and Abatzoglou, 2021) were enabled in part by a warm and dry summer (as is typical in Oregon) that caused vegetation to dry, strong east winds that carried extremely dry air, and

human-caused ignitions.

Human activities have modified fire dynamics in western forests through fragmentation and exploitation of these ecosystems; increased recreational activity; the introduction of highly flammable, non-native annual grasses; and replacement of indigenous or lightning-ignited fires by extensive fire suppression and vegetation management. Over 68% of Linn County, mostly private land in the Coast Range and federal land in the Cascade Range, is classified as evergreen forest (Oregon Explorer, 2023). Twenty four percent of the county is classified as agricultural and three percent as urban.

Over 80% of ignitions in the United States are now human-caused (Balch *et al.*, 2017), and human-caused ignitions accounted for 67% of the fire starts in Linn County from 1992 through 2020 (Figure 24) (Short, 2022). As detailed below, longer summers and human activities have increased the temporal and geographic extent of the fire season (Balch *et al.*, 2017; Bowman *et al.*, 2020; Jones *et al.*, 2022), increasing the probability that an ignition in late summer could spread across large areas of timberland and remnants of old growth.

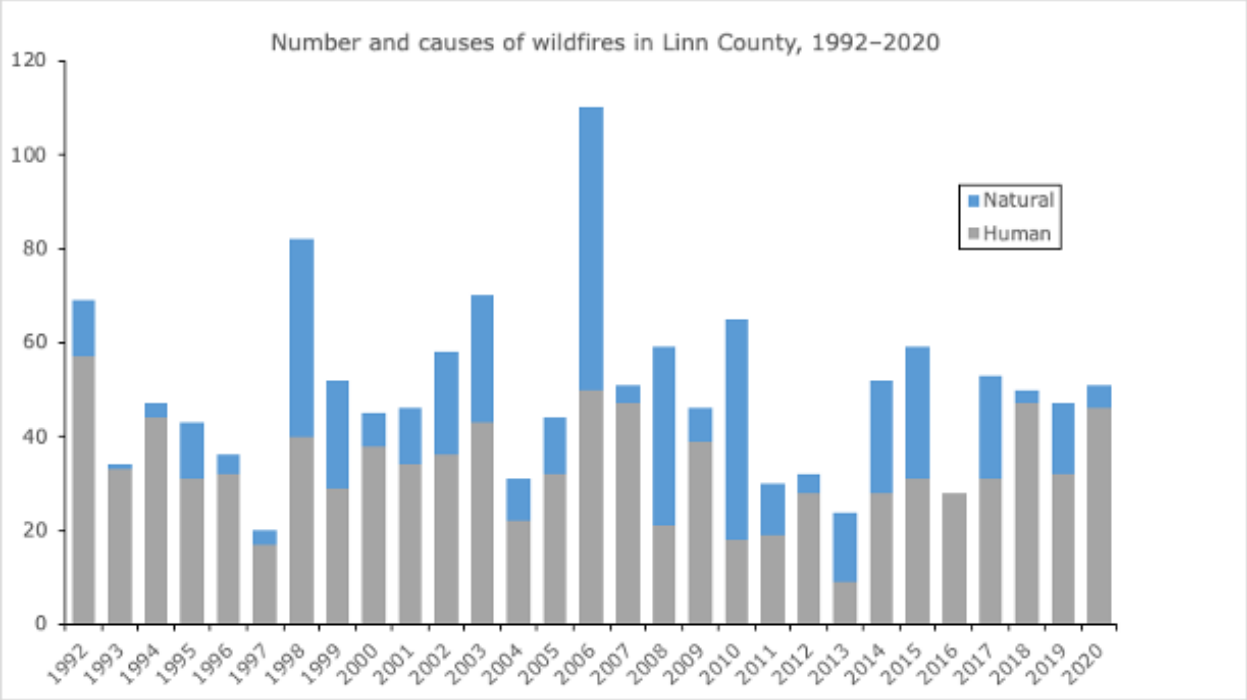

Figure 24. Number and causes of wildfires in Linn County, 1992–2020.

Management practices likely affected the severity of the 2020 wildfires in Oregon (Allen *et al.*, 2019; Downing *et al.*, 2022). Uniform canopy structure, which is common in forest plantations on private lands, can lead to subcanopy winds that transport moisture out of the watershed (Drake *et al.*, 2022). Crowning and torching associated with dry trees may increase the potential for long-distance spot fires that can cause rapid expansion of the fire front and overwhelm suppression efforts (Rothermel, 1991; Koo *et al.*, 2010; Storey *et al.*, 2020). Firebrands can be carried far by strong winds: in September 2017, embers from the Eagle Creek fire jumped across the Columbia River and started some spot fires on the Washington side.

Duration and Magnitude of Wildfire Risk

The duration of the wildfire season is increasing across the western United States (Dennison *et al.*, 2014; Jolly *et al.*, 2015; Westerling, 2016; Williams and Abatzoglou, 2016), and the duration of the fire weather season in forests of the Northwest increased by 43% from 1979 through 2019 (Jones *et al.*, 2022). Accelerated warming and drying at higher elevations has made wildfire possible in an additional 11% of forests in mountains of the western United States (Alizadeh *et al.*, 2021). Anthropogenic emissions increased the likelihood of extreme fire weather during fall by about 40% over the western United States and about 50% over western Oregon, largely because vegetation in fall is becoming drier and warmer temperatures are coinciding with dry winds (Hawkins *et al.*, 2022). Similarly, the number of days per year on which fire danger was extreme increased by 166% from 1979 through 2019 (Jones *et al.*, 2022). Extreme fire danger is defined as the highest 5% of values of the Canadian Fire Weather Index, which is based on estimates of fuel moisture derived from temperature, precipitation, humidity, and wind (Van Wagner, 1987; Jones *et al.*, 2022).

The Northwest Interagency Coordination Center (gacc.nifc.gov/nwcc) uses the 100-hour fuel moisture (FM100) index to predict fire danger. FM100 is a measure of the percentage of moisture in dead vegetation of 1–3 inch diameter and is calculated from precipitation, temperature, and relative humidity according to the equations in the National Fire Danger Rating System (Bradshaw *et al.*, 1984). A majority of climate models project that FM100 will decline by the 2050s (2040–2069) under the higher emissions scenario (Gergel *et al.*, 2017), increasing fire danger across Oregon. Projections of the Keetch–Byram Drought Index, a common fire index that is based on the response of vegetation moisture to precipitation and temperature, suggested that within the Northwest, the area with high fire danger in summer will increase by 345% from 1996–2004 to 2086–2094 under the higher emissions scenario (Brown *et al.*, 2021). All of these methods project that in Oregon, the number of summer days with high fire danger will increase through the end of the twenty-first century, particularly in the Cascade Range, Coast Range, and Klamath Mountains (Brown *et al.*, 2021).

Projected Wildfire Risk in Linn County

Here, we estimate the future change in wildfire risk with two metrics, FM100 and VPD, that are proxies for extreme fire danger, or conditions under which wildfire is likely to spread. Minimum FM100 averaged over Linn County decreased by 0.19% per decade (p-value = 0.04) from 1979–2022. Likewise, maximum VPD during the fire season (March–October) increased by 0.13 kPa per decade (p-value < 0.001) from 1979–2022 (Figure 25). These trends are consistent with regional warming and drying trends. We present projected changes in the average annual number of days on which fire danger, as measured by

FM100, is very high and VPD is extreme for two future periods, both of which we compared to the historical baseline (1971–2000 average), under two emissions scenarios.

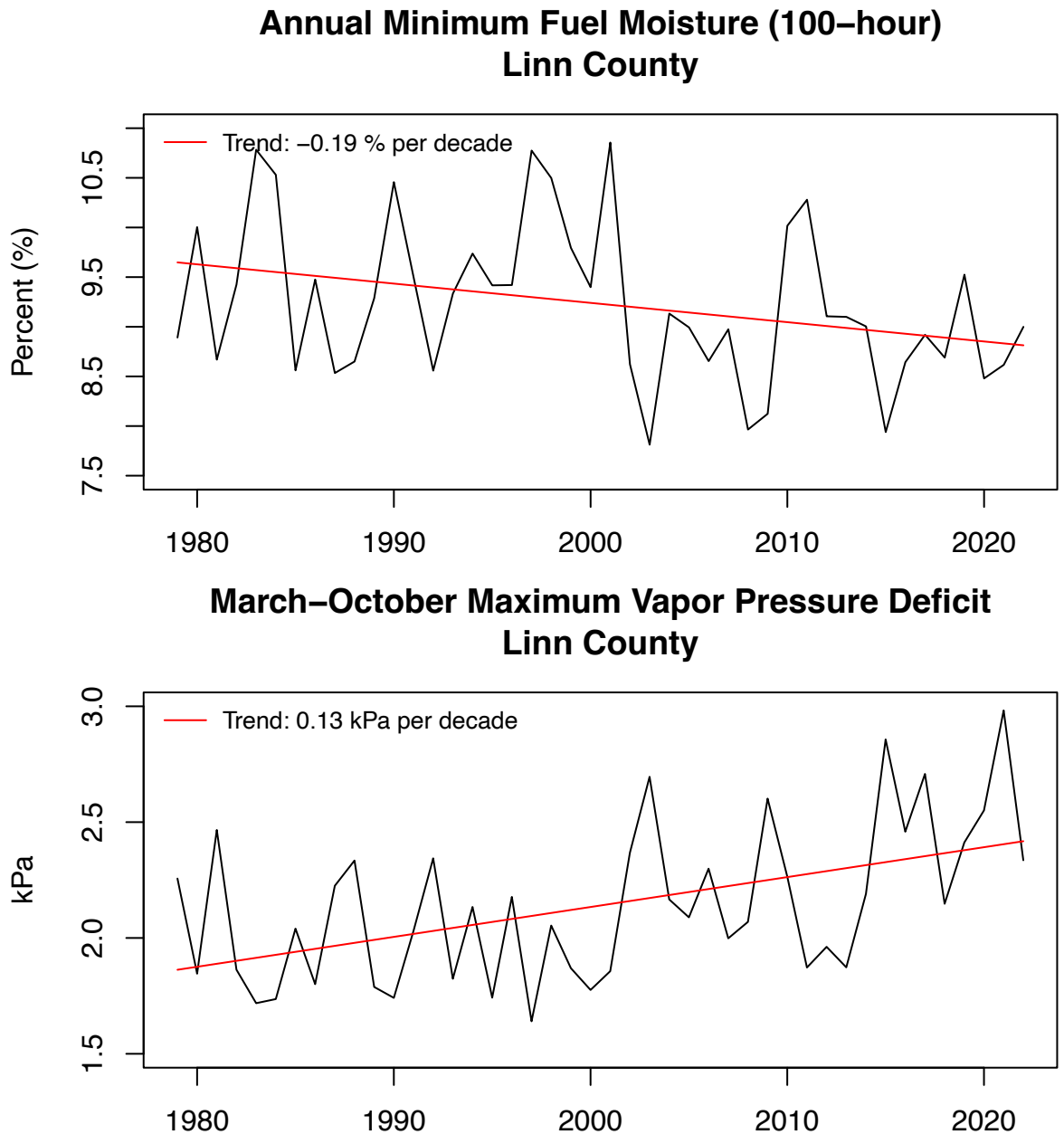

Figure 25. Annual minimum 100-hour fuel moisture (top) and March–October maximum vapor pressure deficit (bottom) averaged over Linn County from 1979–2022. (Data source: gridMET accessed via Climateengine.org)

We define a day with very high fire danger as one on which the FM100 value (moisture on the forest floor or at the base of other vegetation) is comparable to the lowest (driest) 10% of values within the historical baseline period. Over the period 1979–2022, 10% of observed FM100 values were below 12.2%, and fire danger was very high on an average of

36.5 days per year. By the 2050s under the higher emissions scenario, the average number of days per year on which fire danger is very high in Linn County is projected to increase by 12 (range -6–31) (Figure 26).

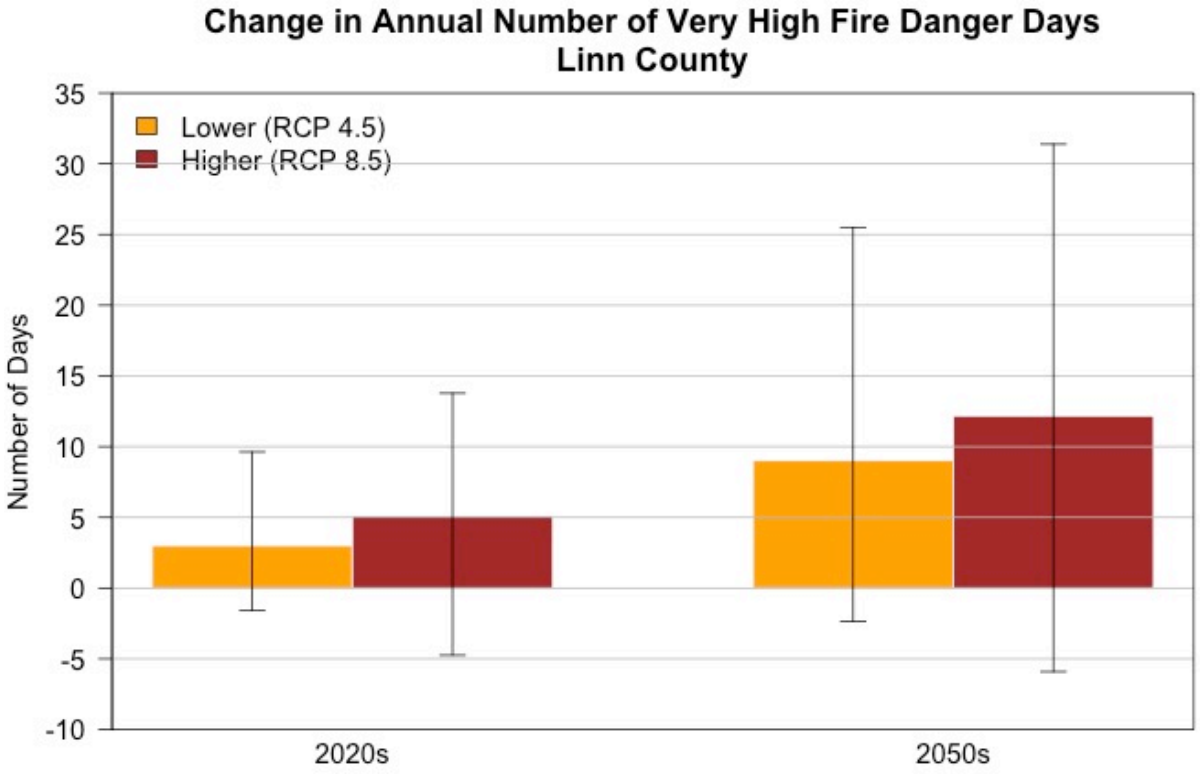

Figure 26. Projected changes by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the 1971–2000 historical baseline and under two emissions scenarios, in the number of days on which fire danger in Linn County is very high. Changes were calculated for each of 18 global climate models relative to each model's historical baseline, then averaged. Whiskers represent the range of changes across the 18 models. Eighteen of the full set of 20 models that were used to project temperature and precipitation included the data necessary to estimate fire danger. (Data source: Climate Toolbox, climatetoolbox.org/tool/Climate-Mapper)

Similarly, we define a day with extreme VPD (dry air) as a day within the warm season (March–October) on which VPD is comparable to the highest (driest) 10% of values within the historical baseline period. Over the period 1979–2022, 10% of observed VPD values from March through October exceeded 1.15 kPa. The 10% threshold for the simulated historical baseline (1971–2000) averaged 1.31 kPa, and VPD was extreme on an average of 24.5 days per year. Under the higher emissions scenario, the average number of days per year on which VPD is extreme in Linn County is projected to increase by 28 (range 10–43) by the 2050s (Figure 27).

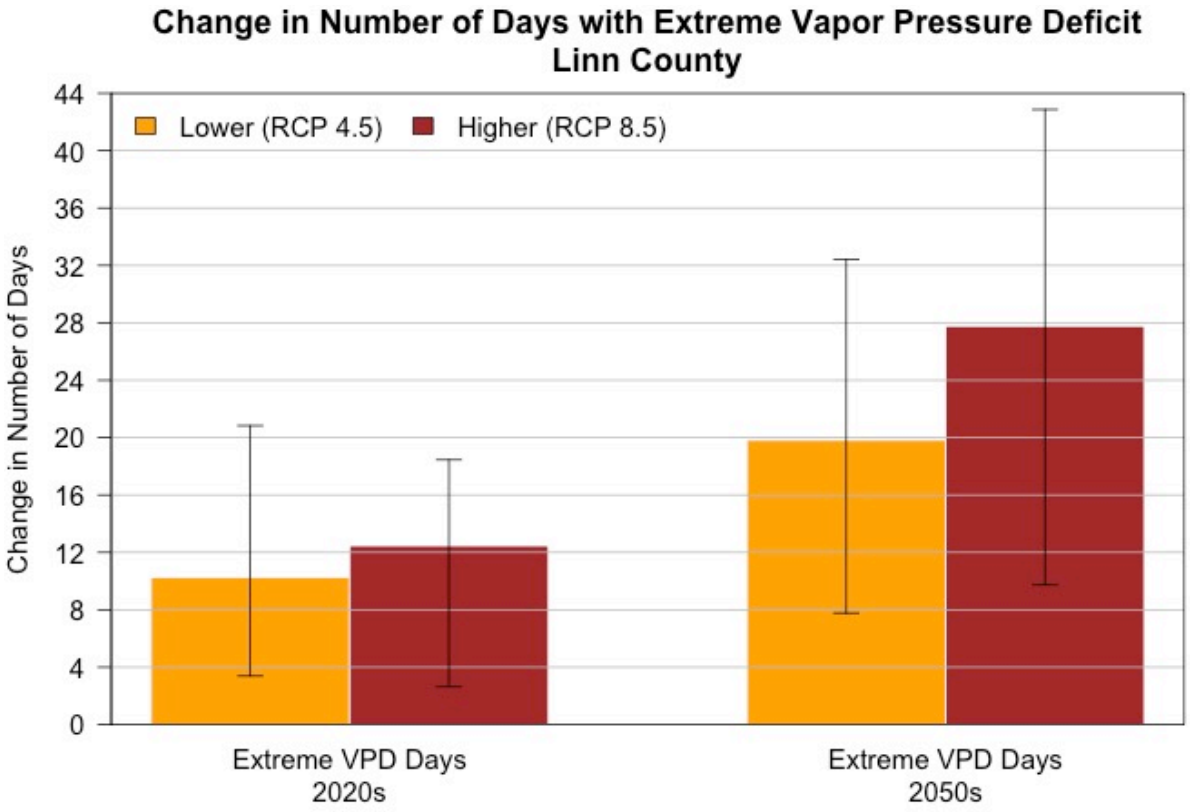

Figure 27. Projected changes by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the 1971–2000 historical baseline and under two emissions scenarios, in the number of days on which vapor pressure deficit in Linn County is extreme. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged. Whiskers represent the range of changes across the 20 models. (Data source: Climate Toolbox, climatetoolbox.org/tool/Climate-Mapper)

Summary

Wildfire frequency and area burned are projected to continue increasing in the Northwest, and wildfire intensity is projected to increase. Wildfire risk, expressed as the average number of days per year on which fire danger is very high, is projected to increase in Linn County by 12 days (range -6–31) by the 2050s. The average number of days per year on which vapor pressure deficit is extreme is projected to increase by 28 (range 10–43) by the 2050s.

Reduced Air Quality

Climate change is expected to reduce outdoor air quality. Warmer temperatures may cause an increase in ground-level ozone concentrations, while more numerous and intense wildfires generate higher concentrations of fine particulate matter (particles less than 2.5 micrometers in diameter [$PM_{2.5}$]) and other pollutants (Rohlman *et al.*, 2023). Moreover, increases in pollen abundance and the duration of the pollen season are likely to increase concentrations of airborne allergens.

Poor air quality is expected to exacerbate allergy and asthma conditions and increase the incidence of respiratory and cardiovascular illnesses and death (Fann *et al.*, 2016). Excess asthma events due to $PM_{2.5}$ from wildfire smoke are projected to increase in Oregon by about 42 per 10,000 persons, resulting in a projected increase in cost of more than $250,000 per 10,000 persons (Stowell *et al.*, 2021). Those at high risk of adverse health outcomes as a result of wildfire smoke include people with preexisting conditions, outdoor workers, children, pregnant people, older adults, and rural and tribal communities (York *et al.*, 2020; Ho *et al.*, 2021). Poor air quality and increases in airborne allergens are most likely to affect communities with low incomes, high non-White or farmworker populations, or that are near highways and industrial facilities; outdoor workers; and those with preexisting conditions (York *et al.*, 2020; Ho *et al.*, 2021). Recent and projected estimates of many of these populations are presented in previous sections.

Wildfire Smoke

Over the past several decades, the wildfire season has become longer. Wildfire severity, often defined as the percentage of vegetation mortality within a fire perimeter, also may increase, especially in relatively wet ecosystems and at high elevations (Rogers *et al.*, 2011; Creutzburg *et al.*, 2017; Halofsky *et al.*, 2020). These changes are a result of factors including traditional forest management practices (Downing *et al.*, 2022), increasing human population density in areas with high fire risk (Radeloff *et al.*, 2018), and climate change (Sheehan *et al.*, 2015). Wildfire smoke poses a much greater threat, in terms of deaths and total costs to society, than wildfire flames per se (Fleishman, 2023). Wildfire smoke also impairs visibility near ground level and at altitudes where firefighting aircraft and evacuation helicopters fly (Nolte *et al.*, 2018). Hazardous levels of air pollution are most common near wildfires, but extensive fires in the western United States and Canada in recent decades have generated taller plumes of smoke and injected a greater volume of $PM_{2.5}$ at high altitudes, increasing long-range transport of these particulates and posing a health hazard to larger numbers of people both near to and far from those wildfires (Wilmot *et al.*, 2022; Rupp and Holz, 2023).

Wildfires are the primary cause of exceedances of air quality standards for $PM_{2.5}$ in western Oregon and parts of eastern Oregon (Liu *et al.*, 2016), particularly in August and September (Wilmot *et al.*, 2021). Woodstove smoke and diesel emissions, especially under winter inversion layers, also contribute to poor air quality in Oregon (DEQ, 2016; Liu and Peng, 2019). Fine particulate matter from vehicles, woodstoves, and power plants can be regulated, but it is much more difficult to control wildfires. From 2013–2022, the U.S. Environmental Protection Agency's Air Quality Index (AQI) in Albany was unhealthy for

sensitive groups or worse as a result of wildfire smoke on an average of 2.5 days per year, as compared to 0 from 2003–2012 (DEQ, 2023).

Across the western United States, $PM_{2.5}$ concentrations from wildfires are projected to increase 160% by 2046–2051, relative to 2004–2009, under a moderate emissions scenario (SRES A1B) (Liu *et al.*, 2016). The SRES A1B scenario, which is from a generation of emissions scenarios that preceded CMIP5, is most similar to RCP 6.0 (**Error! Reference source not found.**). CMIP6 models that were integrated with an empirical statistical model projected that $PM_{2.5}$ concentrations in August and September in the Northwest will double under a lower (SSP5-4.5) emissions scenario and triple under a higher (SSP5-8.5) emissions scenario by 2080–2100 compared to 1997–2020 (Xie *et al.*, 2022).

Exposure to $PM_{2.5}$ aggravates chronic cardiovascular and respiratory illnesses (Cascio, 2018). In addition, because exposure to $PM_{2.5}$ increases susceptibility to viral respiratory infections, exposure to wildfire smoke is likely to increase susceptibility to and the severity of reactions from COVID-19 (Henderson, 2020). During 2020, in 18 of 19 Oregon counties analyzed, the number of reported COVID-19 cases increased on days with active wildfire smoke (Zhou *et al.*, 2021). Active wildfire smoke was defined as concentrations of $PM_{2.5}$ that exceeded 21 $\mu g\ m^{-3}$, a value within the moderate category of the AQI. Furthermore, wildfire smoke can disrupt outdoor recreational and social activities, in turn affecting physical and mental health (Nolte *et al.*, 2018). For example, on September 11, 2020, Portland's air quality deteriorated to hazardous and was the worst among major cities worldwide, causing many park closures and halting most outdoor activities (Green, 2020). The same year, wildfire smoke caused four days of hazardous, six days of very unhealthy, and one day of unhealthy air in Albany (DEQ, 2023).

Wildfires emit ozone precursors that in hot and sunny conditions react with other pollutants to increase the concentration of ozone. From 2000 through 2020, the frequency, duration, and area of co-occurrence of $PM_{2.5}$ and ozone increased in the western United States (Kalashnikov *et al.*, 2022), including the Pacific Northwest (Buchholz *et al.*, 2022). The population exposed to persistent extreme $PM_{2.5}$ and ozone levels in the West increased by 25 million person-days per year over the period 2001–2020 (Kalashnikov *et al.*, 2022; Rupp and Holz, 2023).

Projected Changes in Air Quality in Linn County

We present projections of future air quality that are based on $PM_{2.5}$ from wildfire smoke. Smoke wave days are defined as two or more consecutive days on which simulated, county-averaged, wildfire-derived $PM_{2.5}$ values are in the highest 2% of simulated daily values from 2004 through 2009 (Liu *et al.*, 2016). Smoke wave intensity is defined as the concentration of $PM_{2.5}$ on smoke wave days. Liu *et al*. (2016) projected mean number of smoke wave days and mean smoke wave intensity for two six-year periods, 2004–2009 and 2046–2051, under a moderate emissions scenario. More information about their methods is in the appendix. The number of smoke wave days in Linn County is projected to increase by 13% and the intensity of smoke on those days is projected to increase by 88% (Figure 28).

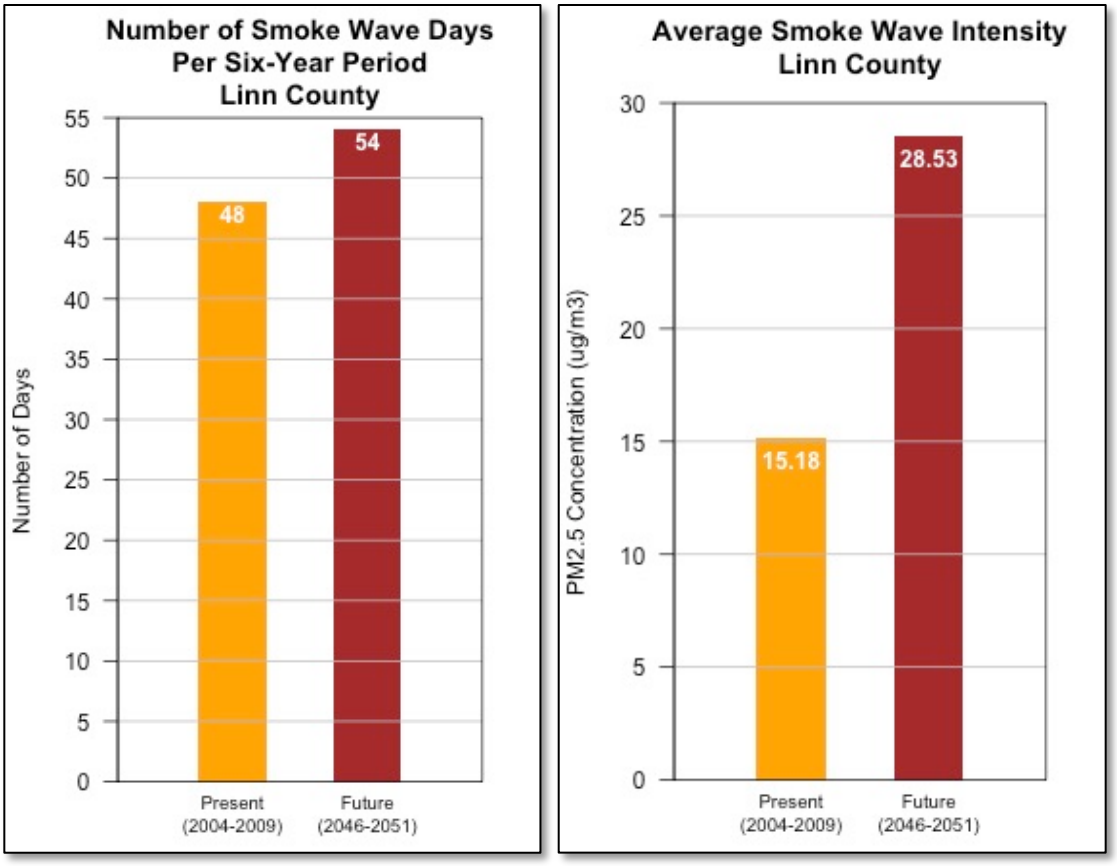

Figure 28. Simulated present (2004–2009) and future (2046–2051) number (left) and intensity (right) of smoke wave days in Linn County under a moderate emissions scenario. Values represent the average among 15 global climate models. (Data source: Liu et al. 2016, khanotations.github.io/smoke-map)

Allergens and Other Airborne Organic Materials

Many plants are responding to changes in climate and atmospheric concentrations of carbon dioxide by producing more pollen, and by producing it earlier in spring and for longer periods of time (Ziska *et al.*, 2009). From 1990 through 2018, the duration of pollen seasons increased by about 20 days and pollen concentration increased by 21% in the conterminous United States (Anderegg *et al.*, 2021), including northern California (Paudel *et al.*, 2021).

Fungal spores could also become more abundant following extreme floods or droughts, which are expected to become more common. The period during which outdoor airborne mold spores are detectable increased in the last 20 years as a result of increasing concentrations of carbon dioxide and changes in climate and land use (Paudel *et al.*, 2021). Furthermore, because both ozone and fine particulate matter affect the sensitivity of respiratory systems to airborne allergens, the combined effects of climate change, air pollution, and changes in vegetation phenology will likely increase the severity of respiratory diseases and allergies (D'Amato *et al.*, 2020).

Summary

Climate change is expected to reduce outdoor air quality. The risks to human health from wildfire smoke in Linn County are projected to increase. From 2004–2009 to 2046–2051, under a moderate emissions scenario, the number of days per year with poor air quality due to elevated concentrations of wildfire-derived fine particulate matter is projected to increase by 13%. The concentration of fine particulate matter on those days is projected to increase by 88%.

Loss of Wetlands

In the United States, wetlands are defined under the Clean Water Act as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Wetlands also may be associated with the edges of lakes and with streams and rivers (Halofsky *et al.*, 2019).

The extent of historic wetlands in the Willamette Valley has been reduced by an estimated 57–95% by agriculture, urbanization, timber harvest, and channelization of the Willamette River (Baker *et al.*, 2004; Christy and Alverson, 2011; Fickas *et al.*, 2016). About 4.3% of emergent, lacustrine, riparian, and riverine wetland area within the two-year floodplain inundation zone along the main stem Willamette River changed (became larger or smaller or changed among the latter four classes) from 1972 through 2012 (Fickas *et al.*, 2016). The majority of losses resulted from conversion to agriculture (Daggett *et al.*, 1998; Bernert *et al.*, 1999; Fickas *et al.*, 2016), and the greatest proportion of change reflected conversion of riparian to riverine wetland (Fickas *et al.*, 2016). Some of the gains and losses in area related to agriculture may have been prompted by drought—creation of ponds in the former case, and farming of newly dry lands in the latter—and may not be permanent (Bernert *et al.*, 1999).

Wetlands and their associated plants and animals are likely to be affected by increases in air temperature, which generally are correlated with increases in freshwater temperature; decreases in snowpack and summer stream flows; and increases in evapotranspiration (Lee *et al.*, 2015) and vapor pressure deficit. Projected effects in the Northwest include reductions in water levels and hydroperiod duration, and may be most pronounced in wetlands that become temporary in dry years (Lee *et al.*, 2015). Wetlands along low-gradient, wide valley bottoms that are dominated by riparian trees and understory species may be most susceptible to decreases in flow and water volume, in part because recruitment of some riparian plant species depends on seasonal flooding (Dwire *et al.*, 2018). Wetlands that are fed primarily by ground water may have more consistent temperature, water chemistry, and water levels than wetlands that are fed primarily by surface water (Halofsky *et al.*, 2019). However, effects of climate change on ground water aquifers that are recharged by snowpack are uncertain (Dwire *et al.*, 2018). Moreover, where increasing aridity leads to greater withdrawal of ground water that cannot readily be recharged, decreases in ground water availability may affect wetlands.

Withdrawals of groundwater were identified as a concern in the Natural Resources Conservation Service's 2016 strategic plan for conservation in Linn County, as were release of toxicants into groundwater and surface water (NRCS, 2016). Additionally, changes in vegetation at the perimeter of wetlands that result from land use or changes in climate, such as replacement of riparian hardwoods to conifers and shrubs (Dwire *et al.*, 2018), may affect water temperatures (Halofsky *et al.*, 2019), chemistry, and nutrient cycles. If increases in temperature and evaporative demand or decreases in water availability increase use of wetlands by domestic livestock, habitat quality for native species likely will decrease.

As of 2001, an estimated 17,532 acres (1.2%) in Linn County were wetlands (NRCS, 2016). Analysis and classification of soils estimated that historically, 156,300 acres (16%) of the county may have been wetland, including but not limited to wet prairies, vernal pool, and riparian areas (NRCS, 2016). Wet prairies, wet meadows, and other wetlands along the Lower and North Santiam Rivers and Central Cascades Crest and in the Willamette River floodplain, Kingston Prairie, One Horse Slough and Beaver Creek, and Coburg Ridge were among the locations in Linn County designated as Wildlife Conservation Opportunity areas by the Oregon Department of Fish and Wildlife (NRCS, 2016). Prairies southeast of Scio are particularly high-priority targets for conservation and restoration (NRCS, 2016).

The Natural Resources Conservation Service restored about 1500 acres distributed among nine wetlands, primarily wet prairies, in Linn County through Wetland Reserve Program easements. These voluntary easements provide landowners and Tribes with technical and financial support for wetland protection, restoration, and enhancement. Wet prairies in Linn County traditionally have been a high priority for conservation in part because they provide habitat for Bradshaw's lomatium (*Lomatium bradshawii*), a species previously listed as endangered under the U.S. Endangered Species Act that was delisted in March 2021 due to recovery.

Summary

In Linn County, losses of wetlands in recent decades largely were caused by conversion to agriculture. Projected effects of climate change on wetlands in the Northwest include reductions in water levels and hydroperiod duration. If withdrawals of ground water do not increase, then wetlands that are fed by ground water rather than surface water may be more resilient to climate change.

Windstorms

Wind patterns in the northwestern United States affect natural disturbances, public health, and multiple sectors. For example, variability in wind speed affects generation of wind power and, when winds cause power lines to fall, the reliability of electricity transmission and risk of fire ignition. Changes in wind speed and direction also affect the safety of transportation by air, land, and sea and the spread of wildfires and pollutants, including wildfire smoke and allergens. In Oregon, average near-surface wind speeds are expected to decrease slightly in response to global climate change (Pryor *et al.*, 2012; Jeong and Sushama, 2019; Chen, 2020; Mass *et al.*, 2022). However, a decrease in the average wind speed may not translate to a decrease in the speed of strong winds. Although projections are highly uncertain, climate models tend to agree that the magnitude of extreme wind speed will increase in western Oregon (Pryor *et al.*, 2012; Jeong and Sushama, 2019). Such increases are not projected in eastern Oregon. An extreme wind refers to an annual maximum wind speed with a given average return period, such as 20 or 50 years (annual exceedance probability of 5% or 2%, respectively).

Oregon's location accounts for some of the uncertainty in the response of strong winds to human-caused emissions of greenhouse gases. The state's most severe windstorms occur from October through April and are associated with extratropical cyclones (cyclones that occur from 30–60˚ latitude) (Read, 2003, 2007; Mass and Dotson, 2010). Cyclones are rotating, organized systems of clouds and thunderstorms that have closed, low-level circulation. Depending on where they originate, strong cyclones are classified as tropical depressions, storms, or cyclones; hurricanes; or typhoons.

Future changes in wind speeds in extratropical cyclones are expected to be small, but the projected poleward shift in the tracks of these cyclones could lead to substantial changes in extreme wind speeds in some regions (Seneviratne *et al.*, 2021). One study indicated that by 2081–2099 relative to 1981–1999, assuming the higher emissions scenario, extratropical cyclones that generate severe winds will shift northward by an average of 2.2° over the North Pacific Ocean (Seiler and Zwiers, 2016). Therefore, these extratropical cyclones will become more frequent north of 45°N and less frequent and weaker south of 45°N. Oregon lies between about 42˚N and 46˚N. Accordingly, although Seiler and Zwiers (2016) did not examine the landfall location of severe cyclones, it is uncertain whether the frequency of severe landfalling extratropical cyclones and the distribution of wind speeds will change in Oregon.

The intensity of strong offshore (easterly) winds, which are most common in summer and in fall before the onset of the rainy season, typically is lower than that of winter windstorms. Nevertheless, offshore winds play a major role in summer heat waves in Oregon, including the record-breaking June 2021 heat wave (Chang *et al.*, 2021), because they displace cooler marine air west of the Cascade Range (Brewer and Mass, 2016). Projections from global climate models, assuming the higher emissions scenario, suggest a decrease in the frequency of strong offshore winds over western Oregon and Washington in July and August, with about a 50% reduction from 1970–1999 to 2071–2100 in the number of days with easterly wind speeds greater than approximately 11 miles per hour (5

meters per second) measured at approximately 5000 feet (1.5 km or 850-hPa) above Earth's surface (Brewer and Mass, 2016).

Understanding of how anthropogenic emissions may affect local winds in Oregon remains limited. Due to their coarse spatial resolution, global climate models and all but the highest-resolution regional climate models cannot adequately simulate mountain slope, valley, and coastal winds, sea breezes, and winds associated with mesoscale convective systems (Doblas-Reyes *et al.*, 2021). Large numbers of simulations from multiple high-resolution (1 to 10 km [0.6 to 6 mi]) regional climate models ultimately will be required to estimate changes in these types of winds across Oregon with moderate to high confidence.

Summary

Wind patterns affect provision of electricity, transportation safety, fire ignition, and the spread of wildfires and pollutants. Mean wind speeds in Oregon are projected to decrease slightly, but extreme winter wind speeds may increase, especially in western Oregon. The frequency of strong easterly winds during summer and fall, however, is projected to decrease slightly.

Expansion of Non-native Invasive Species

Changes in climate and atmospheric concentrations of carbon dioxide can affect the distribution and population dynamics of native and non-native species of animals and plants that are considered to be invasive or pests in natural and agricultural systems. Species-environment relations are not static (MacDonald, 2010; Walsworth *et al.*, 2019). Therefore, even when the current ecology of a species is well understood, it often is difficult to predict with confidence how the species will respond to projected changes in climate, especially when climate change interacts with land-use change or other environmental changes. Species adapt not only in response to climate change but in response to all types of environmental change, including management actions (Thomas *et al.*, 1979; Skelly *et al.*, 2007; Winter *et al.*, 2016). These responses may be rapid, on the order of years or decades, particularly among organisms with short generation times (Boughton, 1999; MacDonald *et al.*, 2008; Willis and MacDonald, 2011; Singer, 2017). Adaptive capacity also is affected by whether individuals can move freely or whether habitat fragmentation and other barriers impede movement (Thorne *et al.*, 2008; Willis and MacDonald, 2011; Fleishman and Murphy, 2012). Monocultures, dense populations, and even-aged populations of animals or plants generally are more susceptible to pests and pathogens than individuals in areas with higher species richness or populations with greater demographic diversity.

The Oregon Conservation Strategy lists 31 non-native invasive species of terrestrial and aquatic animals that have been documented in the Willamette Valley (ODFW, 2016) (Table 16); these species may occur in Linn County. Climate change is unlikely to have a major effect on the status of non-native invasive animals in Linn County given that most are widespread generalists that exploit human-dominated environments and compete effectively with native species. Aquatic species may be adversely affected if the amount or quality of their habitat declines as a function of aridification and human appropriation of surface water and ground water, but it is unclear whether their competitive interactions with native species will change. There is some evidence that as temperature increases, increases in metabolic rate in turtles, such as red-eared and yellow bellied sliders (*Trachemys scripta elegans*, *T. scripta scripta*), will reduce their survival and fitness (Willette *et al.*, 2005). Sex ratios of reptiles with temperature-dependent sex determination also may become skewed as temperatures increase (Mitchell and Janzen, 2010). Again, however, these effects will not be limited to non-native taxa.

Table 16. Non-native invasive species of animals with documented occurrences in the Willamette Valley (Oregon Conservation Strategy 2016).

Mammals
Black rat (*Rattus rattus*)
Brown rat (*Rattus norvegicus*)
Eastern fox squirrel (*Sciurus niger*)
Eastern gray squirrel (*Sciurus carolinensis*)
Feral swine (*Sus scrofa*)
Nutria (*Myocastor coypus*)
Red fox (*Vulpes vulpes*)
Virginia opossum (*Didelphis virginiana*)

Reptiles and amphibians
American bullfrog (*Lithobates catesbeianus*)
Common snapping turtle (*Chelydra serpentina*)
Red-eared slider (*Trachemys scripta elegans*)
Yellow bellied slider (*Trachemys scripta scripta*)
Birds
Eurasian Collared Dove (*Streptopelia decaocto*)
European Starling (*Sturnus vulgaris*)
House Sparrow (*Passer domesticus*)
Mute Swan (*Cygnus olor*)
Rock Pigeon (*Columba livia*)
Fishes
Amur goby (*Rhinogobius brunneus*)
Common carp (*Cyprinus carpio*)
Fathead minnow (*Pimephales promelas*)
Golden shiner (*Notemigonus crysoleucas*)
Goldfish (*Carassius auratus*)
Grass carp (*Ctenopharyngodon idella*)
Western mosquitofish (*Gambusia affinis*)
Molluscs
Asian clam (*Corbicula fluminea*)
Chinese mysterysnail (*Cipangopaludina chinensis malleata*)
New Zealand mudsnail (*Potamopyrgus antipodarum*)
Invertebrates
Freshwater jellyfish (*Craspedacusta sowerbyi*)
Red swamp crayfish (*Procambarus clarkii*)
Ringed crayfish (*Orconectes neglectus*)
Siberian prawn (*Exopalaemon modestus*)

Linn County is part of the Upper Willamette Cooperative Weed Management Area. The Oregon Department of Agriculture weed mapper (www.oregon.gov/oda/programs/weeds/pages/weedmapper.aspx) indicates that more than 40 plants designated by the agency as noxious weeds occur within Linn County (Table 17). Although little is known about how many of these species may to respond to climate change, some evidence suggests how others may be affected. In general, non-native invasive plants in Linn County are likely to become more prevalent in response to projected changes in climate. However, many of these responses are uncertain, and are likely to vary locally. Moreover, the responses may change over time.

Table 17. Noxious weeds reported to occur within Linn County.

Species	Growth form
Armenian blackberry (*Rubus armeniacus*)	Perennial vine

Bull thistle (*Cirsium vulgare*)	Biennial forb
Butterfly bush (*Buddleja davidii*)	Perennial shrub
Canada thistle (*Cirsium arvense*)	Perennial forb
Dalmatian toadflax (*Linaria dalmatica*)	Perennial forb
Diffuse knapweed (*Centaurea diffusa*)	Biennial forb
English hawthorn (*Crataegus monogyna*)	Shrub or small tree
Eurasian watermilfoil (*Myriophyllum spicatum*)	Perennial aquatic
False brome (*Brachypodium sylvaticum)*	Perennial grass
Field bindweed (*Convolvulus arvensis)*	Perennial forb
Giant knotweed (*Fallopia sachalinensis*)	Shrub
Herb Robert (*Geranium robertianum)*	Annual forb
Italian thistle (*Carduus pycnocephalus)*	Annual or biennial forb
Ivy (*Hedera* spp.)	Perennial vine
Japanese knotweed (*Fallopia japonica*)	Shrub
Large-flower primrose-willow (*Ludwigia grandiflora*)	Perennial aquatic
Meadow hawkweed (*Hieracium pratense*)	Perennial forb
Meadow knapweed (*Centaurea pratensis*)	Perennial forb
Mediterranean sage (*Salvia aethiopis*)	Biennial forb
Medusahead rye (*Taeniatherum canput-medusae*)	Annual grass
Milk thistle (*Silybum marianum*)	Biennial or annual forb
Parrots feather (*Myriophyllum aquaticum*)	Annual aquatic
Paterson's curse (*Echium plantagineum)*	Annual forb
Perennial peavine (*Lathyrus latifolius)*	Perennial vine
Perennial pepperweed (*Lepidium latifolium*)	Perennial forb
Poison hemlock (*Conium maculatum)*	Biennial forb
Portuguese broom (*Cytisus striatus)*	Shrub
Primrose-willow (*Ludwigia* spp.)	Perennial aquatic
Purple loosestrife (*Lythrum salicaria*)	Perennial forb
Russian knapweed (*Acroptilon repens*)	Perennial forb
Scotch broom (*Cytisus scoparius*)	Shrub
Shiny leaf geranium (*Geranium lucidum*)	Annual forb
Small broomrape (*Orobanche minor*)	Annual forb
South American waterweed (*Egeria densa*)	Perennial aquatic
Spotted knapweed (*Centaurea stoebe*)	Short-lived perennial forb
St. Johnswort (*Hypericum perforatum*)	Perennial forb
Sulfur cinquefoil (*Potentilla recta*)	Perennial forb
Tansy ragwort (*Senecio jacobaea*)	Biennial or short-lived perennial
Ventenata (*Ventenata dubia*)	Annual grass
Water primrose (*Ludwigia hexapetala*)	Perennial aquatic
Yellow archangel (*Lamiastrum galeobdolon*)	Perennial forb
Yellow flag iris (*Iris pseudocorus*)	Perennial aquatic
Yellow toadflax (*Linaria vulgaris*)	Perennial forb

Carbon Dioxide, Nitrogen, and Ozone Concentrations

Increasing concentrations of carbon dioxide affect some plants' primary productivity, water-use efficiency, and nutrient content. Increases in photosynthesis in response to increases in carbon dioxide are more common in plants with C3 metabolism than in plants with C4 metabolism. C4 metabolism has evolved multiple times, usually as an adaptation to hot, dry climate. Plants with C4 metabolism lose considerably less water per unit of carbon dioxide absorbed, and tend to photosynthesize more efficiently, than plants with C3 metabolism. By contrast, tolerance of the herbicide glyphosate tends to increase more in C4 than in C3 plants as carbon dioxide increases (Chen *et al.*, 2020).

English ivy can benefit from increases in carbon dioxide concentrations, especially when temperatures are relatively warm (Manzanedo *et al.*, 2018). Experiments suggested that the photosynthetic rate and biomass of Canada thistle, and the number and length of the species' spines, are likely to increase as ambient concentrations of carbon dioxide increase throughout the twenty-first century, and may have increased during the twentieth century (Ziska, 2002). Whether the root biomass of Canada thistle responds positively to increases in carbon dioxide concentrations, especially independent of increases in temperature, is unclear (Ziska *et al.*, 2004; Tørresen *et al.*, 2020), and may vary in space.

Changes in climate, ongoing human additions of nitrogen to the environment, and their interactions affect the growth and competitive relations among plant and animal species (Greaver *et al.*, 2016). The competitive advantage of non-native forbs and grasses over native species of plants may be strongest in relatively warm and dry areas, which often coincide with lower elevations (Dodson and Root, 2015). Additionally, non-native invasive plants generally gain a competitive advantage from nitrogen deposition. For example, Japanese knotweed may be more likely to outcompete native species when nitrogen availability is variable or episodic (Parepa *et al.*, 2013). Nevertheless, how field experiments with supplemental nitrogen relate to changes in nitrogen deposition or availability as a result of climate change is uncertain. Japanese knotweed also is fairly tolerant of high temperatures, drought, saturated soils, and fire (Clements and DiTommaso, 2012).

As tropospheric concentrations of ozone continue to increase, productivity of native and agricultural plants generally is expected to decrease. However, ozone tolerance in weedy, vegetatively reproducing species may increase relatively quickly, allowing them to gain a competitive advantage over some crops (Grantz and Shrestha, 2006).

Heat

Many non-native invasive plants tolerate high temperature. For example, warming increased seed mass of diffuse knapweed independent of increases in carbon dioxide (Li *et al.*, 2018). By contrast, reproduction of false brome along a latitudinal gradient in Europe was independent of temperature (growing degree hours above 41˚F after 1 January) (De Frenne *et al.*, 2009).

The flowering phenology of purple loosestrife, which readily colonizes wetlands, is adapted to the duration of the growing season. At northern latitudes, including Oregon, purple loosestrife flowers early, at a small size; at southern latitudes, it flowers later, at a larger

size (Colautti and Barrett, 2013). Early flowering limits reproductive growth of purple loosestrife, and northern plants generally produce fewer seeds and have less population-level genetic variation than southern plants (Colautti *et al.*, 2010). Climate change is expected to prolong the growing season, and therefore to increase the long-term viability of purple loosestrife, although local adaptation may be relatively slow due to genetic constraints of flowering time (Colautti *et al.*, 2010, 2017).

Cold

Responses of invasive plants to changes in temperature are diverse, even within the same species. For example, although it appears that photosynthesis in Japanese knotweed is constrained by temperatures below freezing (Baxendale and Tessier, 2015), the range of the species is expanding northward, perhaps reflecting evolution of frost tolerance (Clements and DiTommaso, 2012). Therefore, Japanese knotweed may become more widespread or abundant as minimum temperatures increase.

Butterfly bush, Scotch broom, and English ivy (*Hedera helix*) usually are not highly tolerant of frost in autumn, although populations can become more frost-tolerant over time (Ebeling *et al.*, 2008; Strelau *et al.*, 2018; Winde *et al.*, 2020).

Precipitation and Drought

Changes in the amount and timing of precipitation may contribute to expansion or contraction of different non-native invasive plants. Some species that occur in Linn County tend to have high drought tolerance. For example, following experimental drought treatment in a seasonally flooded area, percent cover of bull thistle increased five to 13 times (Hogenbirk and Wein, 1991), and in forests in western Oregon, cover of English ivy was associated negatively with summer precipitation (Strelau *et al.*, 2018). By contrast, spotted knapweed may be outcompeted by some native grasses (e.g., bluebunch wheatgrass [*Pseudoroegneria spicata*]) during drought, but may have a competitive advantage when precipitation is closer to average (Pearson *et al.*, 2017). Monocultures of spotted knapweed appear to be less affected by drought (Pearson *et al.*, 2017). Evidence of drought tolerance in Scotch broom is equivocal, especially in the field rather than in greenhouse experiments (Potter *et al.*, 2009; Hogg and Moran, 2020). The growth and survival of Scotch broom in relatively open woodlands and forests may increase as snow depths decrease, especially during the winter after germination (Stevens and Latimer, 2015).

Normal to high precipitation can decrease the viability of certain non-native invasive plants, at least in some contexts. For example, in mixed-grass prairie, addition of snow increased aboveground biomass and density of diffuse knapweed, perhaps conferring a competitive advantage over native plants (Blumenthal *et al.*, 2008). Whether drought limits vegetative growth of purple loosestrife is unclear. Increased spring temperatures and decreased precipitation associated with the El Niño–Southern Oscillation in some parts of the species' range were associated with early flowering and aboveground biomass accumulation, but not with total aboveground biomass, inflorescence lengths (an indicator of reproductive output), timing of senescence (Dech and Nosko, 2004).

Disturbances

The density and distribution of weedy plants tends to increase in response to ground disturbance, whether from wildfire, livestock grazing, recreational activities, or removal of overstory trees and shrubs. For example, both bull thistle and Canada thistle can establish readily in soils that have been disturbed by high-severity wildfires, which may become more common as climate changes, or by logging (Reilly *et al.*, 2020). Some non-native plants also contribute to a positive feedback cycle by increasing the probability of disturbances that facilitate their population growth. To illustrate, the rapid expansion of non-native invasive grasses, such as ventenata grass, has increased fine-fuel biomass and spatial continuity of fuels (Balch *et al.*, 2013; Kerns *et al.*, 2020; Tortorelli *et al.*, 2020).

Summary

In general, non-native invasive plants in Linn County are likely to become more prevalent in response to projected increases in temperature and the frequency, duration, and severity of drought. However, many of these responses are uncertain, are likely to vary locally, and may change over time.

Appendix

We projected future climate and hydrology on the basis of outputs from twenty global climate models (GCM) and two emissions scenarios (Representative Concentration Pathway [RCP] 4.5 and RCP 8.5) from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) (Table A1).

Table A1. The 20 global climate models (GCMs) from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) represented in this report. Asterisks (*) indicate the ten GCMs used as inputs to the Variable Infiltration Capacity hydrological model in the Integrated Scenarios of the Future Northwest Environment project. Carets (^) indicate the GCMs that do not include daily relative humidity. Relative rankings are from Rupp *et al.* (2013).

Model Name	Relative Rank	Modeling Center
BCC-CSM1-1	18	Beijing Climate Center, China Meteorological Administration
BCC-CSM1-1-M*	12	
BNU-ESM	19	College of Global Change and Earth System Science, Beijing Normal University, China
CanESM2*	2	Canadian Centre for Climate Modeling and Analysis
CCSM4*^	5	National Center for Atmospheric Research, USA
CNRM-CM5*	1	National Centre of Meteorological Research, France
CSIRO-Mk3-6-0*	8	Commonwealth Scientific and Industrial Research Organization/Queensland Climate Change Centre of Excellence, Australia
GFDL-ESM2G	14	NOAA Geophysical Fluid Dynamics Laboratory, USA
GFDL-ESM2M	10	
HadGEM2-CC*	4	Met Office Hadley Center, UK
HadGEM2-ES*	3	
INMCM4	11	Institute for Numerical Mathematics, Russia
IPSL-CM5A-LR	13	Institut Pierre Simon Laplace, France
IPSL-CM5A-MR*	6	
IPSL-CM5B-LR	20	
MIROC5*	7	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies, Japan
MIROC-ESM	16	
MIROC-ESM-CHEM	17	
MRI-CGCM3	15	Meteorological Research Institute, Japan

NorESM1-M*^	9	Norwegian Climate Center, Norway

MACA Downscaling

The coarse horizontal resolution of the GCM outputs (100–300 km) was statistically downscaled to a resolution of about 6 km with the Multivariate Adaptive Constructed Analogs (MACA) statistical downscaling method, which is skillful in complex terrain (Abatzoglou and Brown, 2012). A detailed description of the MACA method is at climate.northwestknowledge.net/MACA/MACAmethod.php. The MACA method uses gridded observational data (gridMET) to train the downscaling. It applies bias corrections and matches the spatial patterns of observed coarse-resolution to fine-resolution statistical relations. The downscaled variables include daily maximum and minimum temperature, maximum and minimum relative humidity, specific humidity, precipitation, wind, and downward solar radiation at the surface from 1950 through 2099. All simulated climate data were bias-corrected with quantile mapping, which adjusts simulated values by comparing the cumulative probability distributions of simulated and observed values. In practice, the simulated and observed values of a variable over the historical time period are sorted and ranked, and each value is assigned a probability of exceedance. The bias-corrected value of a given simulated value is assigned the observed value that has the same probability of exceedance as the simulated value. The historical bias in the simulations is assumed to be constant. Therefore, the relations between simulated and observed values in the historical period were applied to the future scenarios. Climate data in the MACA outputs reflect quantile mapping relations for each non-overlapping 15-day window in the calendar year.

Climate and Fire Danger Variables

We used MACA-downscaled minimum and maximum temperature and precipitation data to characterize heat waves, cold waves, and heavy precipitation. We characterized wildfire risk on the basis of vapor pressure deficit (VPD) and 100-hour fuel moisture (FM100), which were computed by the Integrated Scenarios of the Future Northwest Environment project (climate.northwestknowledge.net/IntegratedScenarios) with the MACA climate variables according to the equations in the National Fire Danger Rating System (Bradshaw *et al.*, 1984). FM100 projections are only available for 18 GCMs because two models (CCSM4 and Nor-ESM1-M) do not include relative humidity at a daily time step. Calculation of FM100 requires daily relative humidity data.

Hydrological Simulations and Variables

The Integrated Scenarios project used MACA downscaled climate data as the inputs to their simulations of hydrology, which they ran with the Variable Infiltration Capacity (VIC) hydrological model (VIC version 4.1.2.l; Liang *et al.*, 1994 and updates). VIC was applied to ten GCMs and run on a 1/16° x 1/16° (6 km) grid (Table A1). We used the hydrological simulations of snow water equivalent (SWE), runoff, and soil moisture to project drought. The Integrated Scenarios project bias-corrected hydrology variables (except SWE) for each month with quantile mapping. The project estimated daily streamflow by routing daily runoff from VIC grid cells to selected locations along the stream network. Where records of

naturalized flow were available, the daily streamflow estimates were bias-corrected for each month with quantile mapping. As a result, their statistical distributions matched those of the naturalized streamflows (www.bpa.gov/energy-and-services/power/historical-streamflow-data). We used streamflow data from the Integrated Scenarios project to characterize changes in the timing of seasonal streamflow, which affects the likelihood of drought and flooding, and changes in extreme flood magnitudes.

Air Quality Data

Our projections of air quality are based on smoke wave data from Liu et al. (2016), which are available at khanotations.github.io/smoke-map. We used two variables, "Total # of SW days in 6 yrs" and "Average SW Intensity". The former is the number of days within each time period on which the concentration of fine particulate matter ($PM_{2.5}$), averaged within the county, exceeded the 98th quantile of the distribution of daily, wildfire-specific $PM_{2.5}$ values from 2004 through 2009 (smoke wave days). The latter is the average concentration of $PM_{2.5}$ across smoke wave days within each time period. Liu et al. (2016) used 15 GCMs from the third phase of the Coupled Model Intercomparison Project under a moderate emissions scenario (SRES-A1B) as inputs to a fire prediction model and the GEOS-Chem three-dimensional global chemical transport model. The available data include only the multiple-model mean value (not the range), which should be interpreted as the direction of projected change rather than the actual expected value.

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APPENDIX G:
RESOLUTIONS & FEMA PLAN REVIEW TOOL

Resolutions to be added upon receipt.

Local Mitigation Plan Review Tool

Cover Page

The Local Mitigation Plan Review Tool (PRT) demonstrates how the local mitigation plan meets the regulation in 44 CFR § 201.6 and offers states and FEMA Mitigation Planners an opportunity to provide feedback to the local governments, including special districts.

1. The Multi-Jurisdictional Summary Sheet is a worksheet that is used to document how each jurisdiction met the requirements of the plan elements (Planning Process; Risk Assessment; Mitigation Strategy; Plan Maintenance; Plan Update; and Plan Adoption).
2. The Plan Review Checklist summarizes FEMA's evaluation of whether the plan has addressed all requirements.

For greater clarification of the elements in the Plan Review Checklist, please see Section 4 of this guide. Definitions of the terms and phrases used in the PRT can be found in Appendix E of this guide.

Plan Information	
Jurisdiction(s)	Linn County, Oregon
Title of Plan	Linn County Multijurisdictional Natural Hazards Mitigation Plan
New Plan or Update	Update
Single- or Multi-Jurisdiction	Multi-jurisdiction
Date of Plan	2025
Local Point of Contact	
Title	EMT-B, Emergency Manager
Agency	Linn County Sheriff's Office
Address	1115 Jackson Street SE, Albany, OR 97322
Phone Number	514-812-2274 x4693
Email	RLentz@linnsheriff.org

Additional Point of Contact	
Title	Planning Manager
Agency	Linn County Planning and Building
Address	300 SW 4th Ave, Albany, OR, 97321
Phone Number	541-967-3816 x2360
Email	aboles@co.linn.or.us

Review Information	
State Review	
State Reviewer(s) and Title	Jason Gately
State Review Date	Click or tap to enter a date.
FEMA Review	
FEMA Reviewer(s) and Title	Sarah Hanzel, CERC Planner Joshewa Fulton, FEMA Community Planner
Date Received in FEMA Region	Click or tap to enter a date.
Plan Not Approved	Click or tap to enter a date.
Plan Approvable Pending Adoption	9/9/2025
Plan Approved	Click or tap to enter a date.

Multi-Jurisdictional Summary Sheet

In the boxes for each element, mark if the element is met (Y) or not met (N).

#	Jurisdiction Name	A. Planning Process	B. Risk Assessment	C. Mitigation Strategy	D. Plan Maintenance	E. Plan Update	F. Plan Adoption	G. HHPD Requirements	H. State Requirements
1	Linn County	Y	Y	Y	Y	Y	N	N/A	N/A
2	City of Gates	Y	Y	Y	Y	Y	N	N/A	N/A
3	City of Halsey	Y	Y	Y	Y	Y	N	N/A	N/A
4	City of Harrisburg	Y	Y	Y	Y	Y	N	N/A	N/A
5	City of Lebanon	Y	Y	Y	Y	Y	N	N/A	N/A
6	City of Lyons	Y	Y	Y	Y	Y	N	N/A	N/A
7	City of Millersburg	Y	Y	Y	Y	Y	N	N/A	N/A
8	City of Scio	Y	Y	Y	Y	Y	N	N/A	N/A
9	City of Sodaville	Y	Y	Y	Y	Y	N	N/A	N/A
10	City of Sweet Home	Y	Y	Y	Y	Y	N	N/A	N/A
11	City of Tangent	Y	Y	Y	Y	Y	N	N/A	N/A
12	Lyons Rural Fire District	Y	Y	Y	Y	Y	N	N/A	N/A

Plan Review Checklist

The Plan Review Checklist is completed by FEMA. States and local governments are encouraged, but not required, to use the PRT as a checklist to ensure all requirements have been met prior to submitting the plan for review and approval. The purpose of the checklist is to identify the location of relevant or applicable content in the plan by element/sub-element and to determine if each requirement has been "met" or "not met." FEMA completes the "required revisions" summary at the bottom of each element to clearly explain the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is "not met." Sub-elements in each summary should be referenced using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each element and sub-element are described in detail in Section 4: Local Plan Requirements of this guide.

Plan updates must include information from the current planning process.

If some elements of the plan do not require an update, due to minimal or no changes between updates, the plan must document the reasons for that.

Multi-jurisdictional elements must cover information unique to all participating jurisdictions.

Element A: Planning Process

Element A Requirements	Location in Plan (section and/or page number)	Met / Not Met
A1. Does the plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement 44 CFR § 201.6(c)(1))		
A1-a. Does the plan document how the plan was prepared, including the schedule or time frame and activities that made up the plan's development, as well as who was involved?	Vol. 1, p. 16 Vol. 3, pp. 388-432 (Appendix A)	Met
A1-b. Does the plan list the jurisdiction(s) participating in the plan that seek approval, and describe how they participated in the planning process?	P. 3 (Acknowledgements) Vol. 1, p. 16 Vol. 2, pp. 157-158, 175-176, 196-197, 218-219, 238-239, 257-258, 276-277, 297-298, 317-318, 335-336, 364-365 Vol. 3, pp. 397-420 (Appendix A)	Met

Element A Requirements	Location in Plan (section and/or page number)	Met / Not Met
A2. Does the plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development as well as businesses, academia, and other private and non-profit interests to be involved in the planning process? (Requirement 44 CFR § 201.6(b)(2))		
A2-a. Does the plan identify all stakeholders involved or given an opportunity to be involved in the planning process, and how each stakeholder was presented with this opportunity?	Vol. 1, p. 3, 13, 19 Vol. 2, pp. 157-158, 175-176, 196-197, 218-219, 238-239, 257-258, 276-277, 297-298, 317-318, 335-336, 364-365 Vol. 3, pp. 388-432 (Appendix A)	Met
A3. Does the plan document how the public was involved in the planning process during the drafting stage and prior to plan approval? (Requirement 44 CFR § 201.6(b)(1))		
A3-a. Does the plan document how the public was given the opportunity to be involved in the planning process and how their feedback was included in the plan?	Vol.1, pp. 120-121- Vol. 3, pp. 388-432 (Appendix A)	Met
A4. Does the plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement 44 CFR § 201.6(b)(3))		
A4-a. Does the plan document what existing plans, studies, reports and technical information were reviewed for the development of the plan, as well as how they were incorporated into the document?	Vol. 1, pp. 23, 44-46, 109-110 Vol. 2, pp. 162, 181, 202, 224, 243, 264, 282-283, 303, 322, 344-345, 369 Vol. 3, pp. 434-490 (Appendix B), pp. 528-652 (Appendix E), pp. 654-760 (Appendix F)	Met

ELEMENT A REQUIRED REVISIONS
Required Revision**:** Click or tap here to enter text.

Element B: Risk Assessment

Element B Requirements	Location in Plan (section and/or page number)	Met / Not Met
B1. Does the plan include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction? Does the plan also include information on previous occurrences of hazard events and on the probability of future hazard events? (Requirement 44 CFR § 201.6(c)(2)(i))		
B1-a. Does the plan describe all natural hazards that can affect the jurisdiction(s) in the planning area, and does it provide the rationale if omitting any natural hazards that are commonly recognized to affect the jurisdiction(s) in the planning area?	Vol. 1, pp. 12, 22-120	Met
B1-b. Does the plan include information on the location of each identified hazard?	Dam Failure: pp. 23-25 Drought: p. 28-30 Earthquake: p. 36-37 Flood: pp. 44-46, 53-54 Landslide: pp. 58-59 Smoke/Poor Air Quality: p. 68-70 Volcano: pp. 72-74 Wildfire: pp. 77-80 Extreme Heat: p. 88 Windstorm/Tornado: p. 92-93 Winter Storm/Ice Storm: pp. 97-98	Met

Element B Requirements	Location in Plan (section and/or page number)	Met / Not Met
B1-c. Does the plan describe the extent for each identified hazard?	Dam Failure: pp. 23-25, 340, 477-478 Drought: pp. 28-30 Earthquake: pp. 36-37, 643-647 Flood: pp. 44-46, 648 Landslide: pp. 58-59, 645-647, 649 Smoke/Poor Air Quality: pp. 67-70 Volcano: pp. 72-74 Wildfire: pp. 77-80, 578, 651 Extreme Heat: p. 88 Windstorm/Tornado: p. 92-93 Winter Storm/Ice Storm: pp. 97-99	Met
B1-d. Does the plan include the history of previous hazard events for each identified hazard?	pp. 104-105 Dam Failure: pp. 26, 166, 229, 287, 349 Drought: pp. 30-32 Earthquake: pp. 37-38 Flood: pp. 46-48 Landslide: pp. 59-60 Smoke/Poor Air Quality: pp. 68-69 Volcano: p. 74 Wildfire: p. 80-82 Extreme Heat: pp. 88-89, 674-682 Windstorm/Tornado: p. 93-95 Winter Storm/Ice Storm: pp. 99-101	Met

Element B Requirements	Location in Plan (section and/or page number)	Met / Not Met
B1-e. Does the plan include the probability of future events for each identified hazard, including the type, location and range of anticipated intensities?	pp. 119, 443-444 Dam Failure: p. 26 Drought: pp. 32-33 Earthquake: p. 38-39 Flood: pp. 48-49 Landslide: pp. 60-62 Smoke/Poor Air Quality: p. 70 Volcano: p. 74-75 Wildfire: p. 82 Extreme Heat: pp. 89-90 Windstorm/Tornado: p. 95-96 Winter Storm/Ice Storm: p. 101 pp. 658-661 (Appendix F)	Met
B1-f. For participating jurisdictions in a multi-jurisdictional plan, does the plan describe any hazards that are unique to and/or vary from those affecting the overall planning area?	Vol. 2, pp. 166-169, 185-188, 206-209, 229-232, 247-250, 269-271, 287-291, 307-310, 327-329, 349-352, 373-376	Met

Element B Requirements	Location in Plan (section and/or page number)	Met / Not Met
B2. Does the plan include a summary of the jurisdiction's vulnerability and the impacts on the community from the identified hazards? Does this summary also address National Flood Insurance Program (NFIP)-insured structures that have been repetitively damaged by floods? (Requirement 44 CFR § 201.6(c)(2)(ii))		

B2-a. Does the plan provide an overall summary of each jurisdiction's vulnerability to the identified hazards?	pp. 105-110, 134 Vol. 1 (County Risk Assessment): Dam Failure: pp. 26-27 Drought: p. 33-34 Earthquake: pp. 39-43 Flood: pp. 49-55, 109-110 Landslide: pp. 62-63 Smoke/Poor Air Quality: p. 71-72 Volcano: p. 75-76 Wildfire: p. 83-87 Extreme Heat: pp 90-91 Windstorm/Tornado: pp. 96 Winter Storms/Ice Storms: pp. 102-103 Vol. 2 (Community Addendum): Dam Failure: pp. 166, 229, 287, 349 Drought: pp. 166-167, 185-186, 206, 230, 247, 269, 288, 307-308, 327, 349-350, 373 Earthquake: pp. 167, 186, 207, 230, 247-248, 270, 288, 308, 327, 350, 374 Flood: pp. 167, 186-187, 207-208, 230-231, 248, 270, 288-289, 308-309, 327-328, 350-351, 374-375 Landslide: pp. 168, 249, 270, 328, 351	Met

Element B Requirements	Location in Plan (section and/or page number)	Met / Not Met
	Smoke/Poor Air Quality: pp. 168, 187, 208, 232, 270, 290, 309, 328, 351, 375 Volcano: pp.168-169, 208, 249, 290, 351-352 Wildfire: pp. 169, 187, 209, 232, 249, 270-271, 290, 309, 328-329, 352, 375 Extreme Heat: pp. 167, 186, 207, 230, 248, 270, 288, 308, 327, 350, 374 Windstorm/Tornado: pp. 169, 188, 209, 232, 250, 271, 291, 310, 329, 352, 376 Winter Storm/Ice Storm: pp. 169, 188, 209, 232, 249, 271, 290, 310, 329, 352, 376 Appendix E: pp. 528-652 Extreme Heat: Appendix F, pp. 682-685	

B2-b. For each participating jurisdiction, does the plan describe the potential impacts of each of the identified hazards on each participating jurisdiction?	Vol 1, Executive Summary, p. 12 Vol. 1 (County Risk Assessment): Dam Failure: pp. 26-27 Drought: p. 33-34 Earthquake: pp. 39-43 Flood: pp. 49-55 Landslide: pp. 62-63 Smoke/Poor Air Quality: p. 71 Volcano: p. 75-76 Wildfire: p. 83 Extreme Heat: pp 90-91 Windstorm/Tornado: pp. 96 Winter Storm/Ice Storm: pp. 102-103 Vol. 2 (Community Addendum): Dam Failure: pp. 166, 229, 287, 349 Drought: pp. 166-167, 185-186, 206, 230, 247, 269, 288, 307-308, 327, 349-350, 373 Earthquake: pp. 167, 186, 207, 230, 247-248, 270, 288, 308, 327, 350, 374 Flood: pp. 167, 186-187, 207-208, 230-231, 248, 270, 288-289, 308-309, 327-328, 350-351, 374-375 Landslide: pp. 168, 249, 270, 328, 351 Smoke/Poor Air Quality: pp. 168, 187,	Met

Element B Requirements	Location in Plan (section and/or page number)	Met / Not Met
	208, 232, 270, 290, 309, 328, 351, 375 Volcano: pp.168-169, 208, 249, 290, 351-352 Wildfire: pp. 169, 187, 209, 232, 249, 270-271, 290, 309, 328-329, 352, 375 Extreme Heat: pp. 167, 186, 207, 230, 248, 270, 288, 308, 327, 350, 374 Windstorm/Tornado: pp. 169, 188, 209, 232, 250, 271, 291, 310, 329, 352, 376 Winter Storm/Ice Storm: pp. 169, 188, 209, 232, 249, 271, 290, 310, 329, 352, 376 Earthquake, Flooding, Landslide, Volcano, Wildfire: Appendix E, pp. 528-652 Extreme Heat: Appendix F, pp. 682-685	
B2-c. Does the plan address NFIP-insured structures within each jurisdiction that have been repetitively damaged by floods?	pp. 110	Met
ELEMENT B REQUIRED REVISIONS		
Required Revision**:**		

Element C: Mitigation Strategy

Element C Requirements	Location in Plan (section and/or page number)	Met / Not Met
C1. Does the plan document each participant's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement 44 CFR § 201.6(c)(3))		
C1-a. Does the plan describe how the existing capabilities of each participant are available to support the mitigation strategy? Does this include a discussion of the existing building codes and land use and development ordinances or regulations?	pp. 143-145, 162, 181, 202, 224, 243, 264, 282-283, 303, 322, 344-345, 369, 488-490	Met
C1-b. Does the plan describe each participant's ability to expand and improve the identified capabilities to achieve mitigation?	pp. 143, 162, 181, 202, 224, 243, 264, 283, 303, 322, 345, 369, 488-490, 502-526	Met
C2. Does the plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement 44 CFR § 201.6(c)(3)(ii))		
C2-a. Does the plan contain a narrative description or a table/list of their participation activities?	p. 109-111	Met
C3. Does the plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement 44 CFR § 201.6(c)(3)(i))		
C3-a. Does the plan include goals to reduce the risk from the hazards identified in the plan?	pp. 13, 121	Met
C4. Does the plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement 44 CFR § 201.6(c)(3)(ii))		
C4-a. Does the plan include an analysis of a comprehensive range of actions/projects that each jurisdiction considered to reduce the impacts of hazards identified in the risk assessment?	pp. 127-140, 172-173, 190-194, 213-216, 235-236, 253-255, 273-274, 292-295, 313-315, 331-333, 357-362, 380-382	Met

Element C Requirements	Location in Plan (section and/or page number)	Met / Not Met
C4-b. Does the plan include one or more action(s) per jurisdiction for each of the hazards as identified within the plan's risk assessment?	pp. 127-140, 172-173, 190-194, 213-216, 235-236, 253-255, 273-274, 292-295, 313-315, 331-333, 357-362, 380-382	Met
C5. Does the plan contain an action plan that describes how the actions identified will be prioritized (including a cost-benefit review), implemented, and administered by each jurisdiction? (Requirement 44 CFR § 201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))		
C5-a. Does the plan describe the criteria used for prioritizing actions?	pp. 494-500	Met
C5-b. Does the plan provide the position, office, department or agency responsible for implementing/administrating the identified mitigation actions, as well as potential funding sources and expected time frame?	pp. 127-140, 172-173, 190-194, 213-216, 235-236, 253-255, 273-274, 292-295, 313-315, 331-333, 357-362, 380-382	Met
ELEMENT C REQUIRED REVISIONS		
Required Revision**:**		

Element D: Plan Maintenance

Element D Requirements	Location in Plan (section and/or page number)	Met / Not Met
D1. Is there discussion of how each community will continue public participation in the plan maintenance process? (Requirement 44 CFR § 201.6(c)(4)(iii))		
D1-a. Does the plan describe how communities will continue to seek future public participation after the plan has been approved?	pp. 145-148	Met

Element D Requirements	Location in Plan (section and/or page number)	Met / Not Met
D2. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a five-year cycle)? (Requirement 44 CFR § 201.6(c)(4)(i))		
D2-a. Does the plan describe the process that will be followed to track the progress/status of the mitigation actions identified within the Mitigation Strategy, along with when this process will occur and who will be responsible for the process?	pp. 145-149	Met
D2-b. Does the plan describe the process that will be followed to evaluate the plan for effectiveness? This process must identify the criteria that will be used to evaluate the information in the plan, along with when this process will occur and who will be responsible.	pp. 141-142	Met
D2-c. Does the plan describe the process that will be followed to update the plan, along with when this process will occur and who will be responsible for the process?	pp. 141-149	Met
D3. Does the plan describe a process by which each community will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement 44 CFR § 201.6(c)(4)(ii))		
D3-a. Does the plan describe the process the community will follow to integrate the ideas, information and strategy of the mitigation plan into other planning mechanisms?	p. 149	Met
D3-b. Does the plan identify the planning mechanisms for each plan participant into which the ideas, information and strategy from the mitigation plan may be integrated?	pp. 143-145, 486-490	Met
D3-c. For multi-jurisdictional plans, does the plan describe each participant's individual process for integrating information from the mitigation strategy into their identified planning mechanisms?	pp. 158, 174, 176, 195, 197, 217, 219, 237, 239, 256, 258, 275, 277, 296, 298, 316, 318, 334, 336, 363, 365, 383	Met

ELEMENT D REQUIRED REVISIONS
Required Revision**:** Click or tap here to enter text.

Element E: Plan Update

Element E Requirements	Location in Plan (section and/or page number)	Met / Not Met
E1. Was the plan revised to reflect changes in development? (Requirement 44 CFR § 201.6(d)(3))		
E1-a. Does the plan describe the changes in development that have occurred in hazard-prone areas that have increased or decreased each community's vulnerability since the previous plan was approved?	pp. 466-470, 134-135	Met
E2. Was the plan revised to reflect changes in priorities and progress in local mitigation efforts? (Requirement 44 CFR § 201.6(d)(3))		
E2-a. Does the plan describe how it was revised due to changes in community priorities?	p. 121	Met
E2-b. Does the plan include a status update for all mitigation actions identified in the previous mitigation plan?	pp. 124-140, 170-173, 189-194, 210-216, 233-236, 251-255, 272-274, 292-295, 311-315, 330-333, 353-362, 377-382	Met
E2-c. Does the plan describe how jurisdictions integrated the mitigation plan, when appropriate, into other planning mechanisms?	pp. 132, 139, 173, 202, 211, 353, 358, 488-489	Met
ELEMENT E REQUIRED REVISIONS		
Required Revision: Click or tap here to enter text.		

Element F: Plan Adoption

Element F Requirements	Location in Plan (section and/or page number)	Met / Not Met
F1. For single-jurisdictional plans, has the governing body of the jurisdiction formally adopted the plan to be eligible for certain FEMA assistance? (Requirement 44 CFR § 201.6(c)(5))		
F1-a. Does the participant include documentation of adoption?	Click or tap here to enter text.	Choose an item.

Element F Requirements	Location in Plan (section and/or page number)	Met / Not Met
F2. For multi-jurisdictional plans, has the governing body of each jurisdiction officially adopted the plan to be eligible for certain FEMA assistance? (Requirement 44 CFR § 201.6(c)(5))		
F2-a. Did each participant adopt the plan and provide documentation of that adoption?	pp. 141,157, 175, 197, 218, 238, 257, 276, 298, 317, 336, 364	Not Met
ELEMENT F REQUIRED REVISIONS		
Required Revision**:** F2-a. Upon approval of the plan, provide the final documentation of each participating jurisdiction's adoption resolution.		

Element G: High Hazard Potential Dams (Optional)

HHPD Requirements	Location in Plan (section and/or page number)	Met / Not Met
HHPD1. Did the plan describe the incorporation of existing plans, studies, reports and technical information for HHPDs?		
HHPD1-a. Does the plan describe how the local government worked with local dam owners and/or the state dam safety agency?	pp. 23-24, 340	Choose an item.
HHPD1-b. Does the plan incorporate information shared by the state and/or local dam owners?	23-24, p. 340	Choose an item.
HHPD2. Did the plan address HHPDs in the risk assessment?		
HHPD2-a. Does the plan describe the risks and vulnerabilities to and from HHPDs?	pp. 23-27, 166, 285, 287, 340, 349, 477-478, 566-567	Choose an item.
HHPD2-b. Does the plan document the limitations and describe how to address deficiencies?	pp. 23-27, 340, 566-567	Choose an item.
HHPD3. Did the plan include mitigation goals to reduce long-term vulnerabilities from HHPDs?		
HHPD3-a. Does the plan address how to reduce vulnerabilities to and from HHPDs as part of its own goals or with other long-term strategies?	pp. 121	Choose an item.

HHPD Requirements	Location in Plan (section and/or page number)	Met / Not Met
HHPD3-b. Does the plan link proposed actions to reducing long-term vulnerabilities that are consistent with its goals?	pp. 121-123, 360	Choose an item.
HHPD4-a. Did the plan include actions that address HHPDs and prioritize mitigation actions to reduce vulnerabilities from HHPDs?		
HHPD4-a. Does the plan describe specific actions to address HHPDs?	p. 360	Choose an item.
HHPD4-b. Does the plan describe the criteria used to prioritize actions related to HHPDs?	pp. 494-500	Choose an item.
HHPD4-c. Does the plan identify the position, office, department or agency responsible for implementing and administering the action to mitigate hazards to or from HHPDs?	p. 360	Choose an item.
HHPD Required Revisions		
Required Revision**:** Click or tap here to enter text.		

Element H: Additional State Requirements (Optional)

Element H Requirements	Location in Plan (section and/or page number)	Met / Not Met
This space is for the State to include additional requirements.		
Click or tap here to enter text.	Click or tap here to enter text.	Choose an item.

Plan Assessment

These comments can be used to help guide your annual/regularly scheduled updates and the next plan update.

Element A. Planning Process

Strengths

- The Executive Summary's use of graphics and information highlights are effective for communicating the most important takeaways from the plan update and process. It makes the plan user friendly for both technical and public audiences.
- The plan includes in-depth records of the planning process, such as committee meeting agendas, committee meeting notes, event photos, web pages, etc. This information supports the narrative and will be helpful for future planners guiding an update to the plan.

Opportunities for Improvement

- Give more detail on how the planning team used the feedback from the planning process to inform the plan. The community survey does a good job of capturing the highlights of respondent answers, but does not indicate how these comments and themes were used to inform specific sections of the plan.

Element B. Risk Assessment

Strengths

- The multi-hazard risk assessment, prepared for the plan by the Oregon Department of Geology and Mineral Industries, is a strong component of the plan. It provides a robust factual basis for the plan, has a strong methodology, and clearly articulates information.
- The plan includes a community profile with demographic information, development trends, and other community features. This creates a strong factual basis that can be used during the vulnerability assessment.
- Each city addendum includes a quick reference to each hazard and its relative risk compared to the rest of the county. These tables are strong visuals to help identify and analyze which hazards each community can prioritize.

Opportunities for Improvement

- Consider adding more graphical elements, such as the map plates from the risk assessment (in the main body of the plan). These visuals are effective at communicating important information about risk. When only placed in the appendix, the maps lose some of their strength as a data communication tool.
- The vulnerability assessment can be more closely connected to specific information about the county and the cities that are presented in the community profile.
- The vulnerabilities section of the plan (in the Community Addendum) references improvements that have been made to reduce risk. These updates are an important part of the plan but would

be better suited in a different section of the plan. The vulnerabilities section should analyze present vulnerabilities.
- Point out the data gaps in the studies, reports, and datasets used for the risk assessment. This will help with plan updates when there is new information.
- Where possible, consider using a consistent time period for past events. Some hazard histories go back to 1900 while others only track data back to the 1980s. Using a standardized time period will help make the information more consistently understandable across hazards.

Element C. Mitigation Strategy

Strengths

- The grant programs and resources outlined in Appendix D are a comprehensive view of potential funding and support for mitigation activities.
- The mitigation strategy uses separate tables to identify which actions have been removed from the previous plan.

Opportunities for Improvement

- The useful information found in Appendix D can be used to make a stronger connection between mitigation actions and plausible funding sources. With the next plan update, consider identifying which funding opportunities may be the best fit for a project in the mitigation strategy table.
- The mitigation strategy table for Linn County and Millersburg includes the definitions of short term, medium term, and long term. The mitigation strategy tables for the other cities in this plan should include the same definitions for clarification to the reader.
- The mitigation strategy table uses multiple hazard actions. With the next plan update, consider being more specific about the types of hazards an action will address. This will enhance the strength of the mitigation strategy by making sure that all hazards that affect a community are being addressed through at least one mitigation action.
- With the next plan update, look for mitigation actions that are already a part of other planning efforts in the jurisdiction(s). For example, many transportation or land use planning efforts tie directly to mitigation. Including them in the plan will encourage an integrated approach to address risk.
- The action plan must identify potential funding sources beyond generic terms. Throughout the Mitigation Strategy, generic terms such as “city” are identified. Revise the plan to include more specific information about the possible source of funds.

Element D. Plan Maintenance

Strengths

- Table 4-1, Natural Hazards Mitigation Plan Update Toolkit, is an effective framework for assisting the convener in determining necessary update activities. This is a strong element of the strategy to keep the hazard mitigation plan current with information and insights from multiple parties.

Opportunities for Improvement

- Some examples of public participation opportunities are identified in the plan. With the next plan update, consider building on the previous public engagement process to assess what worked well, what could be improved, and how public engagement can be expanded. Identifying these opportunities prior to the next planning cycle will help to understand any new resources or partners needed to support the effort.

Element E. Plan Update

Strengths

- Table A-1, Plan Update Changes, is a useful quick reference on changes to the organization of the plan. The callout boxes in the hazard profiles are also useful for providing high-level context of what has changed since the last plan was approved.

Opportunities for Improvement

- The introduction to the Mitigation Strategy in Section 3 notes that the steering committee agreed that the 2017 plan's mission statement still captured the mission of Linn County's MJ-NHMP. With the next plan revision, consider including a discussion of any changes to planning documents, demographic or population shifts, land development trends, recent disasters, or other factors that might lead to a different understanding of the county's priorities over time.

Element G. HHPD Requirements (Optional)

Strengths

- [insert comments]

Opportunities for Improvement

- [insert comments]

Element H. Additional State Requirements (Optional)

Strengths

- [insert comments]

Opportunities for Improvement

- [insert comments]

[Placeholder for Resolutions and FEMA Review Tool]