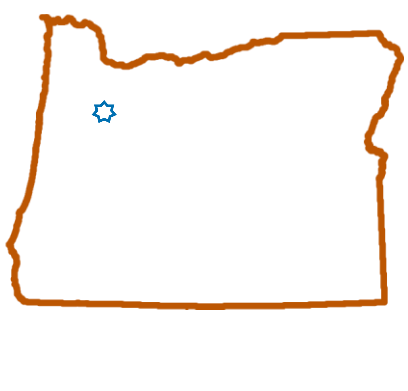


CITY OF Salem
AT YOUR SERVICE



City of Salem

NATURAL HAZARDS MITIGATION PLAN



FEMA

EFFECTIVE DECEMBER 5, 2023 THROUGH DECEMBER 4, 2028

The *2023 Salem Natural Hazard 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 NHMP to receive federal funds for pre- and post-disaster mitigation grants.

Comments, suggestions, corrections, and additions are encouraged to be submitted from all interested parties.

For further information and to provide comments, contact:

Joe Hutchinson
Emergency Manager
City of Salem Fire Department
370 Trade Street, S.E.
Salem, Oregon 97301
jhutchinson@cityofsalem.net
(503) 589-2139

City of Salem developed this Natural Hazards Mitigation Plan through a partnership funded by the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance Grants. In 2022, the Department of Land Conservation and Development (DLCD) received Hazard Mitigation Grant Program (HMGP) for DR-4562-OR from FEMA through the Oregon Department of Emergency Management (OEM) to assist Salem with the NHMP.

Acknowledgements

City of Salem Natural Hazards Mitigation Plan Update Steering Committee

City of Salem

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Brian Carrara, Convener, Deputy Chief of Administration
Anthony Gamallo, Senior Transportation Planner
Austin Ross, Planner II
Brandon Ditto, Police Professional Standards and Training Lieutenant
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Cynthia Smidt, Natural Hazards Planner

CITY OF SALEM RESOLUTION

RESOLUTION NO. 2023-36

A RESOLUTION ADOPTING UPDATES TO THE CITY OF SALEM NATURAL HAZARDS MITIGATION PLAN

Whereas, City of Salem recognizes the threat that natural hazards pose to people, property and infrastructure within our community; and

Whereas, undertaking hazard mitigation actions will reduce the potential for harm to people, property and infrastructure from future hazard occurrences; and

Whereas, an adopted Natural Hazards Mitigation Plan (NHMP) is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and

Whereas, City of Salem fully participated in the FEMA prescribed mitigation planning process to prepare this Natural Hazards Mitigation Plan; and

Whereas, the Oregon Office of Emergency Management and Federal Emergency Management Agency, Region X officials have reviewed the *City of Salem Natural Hazard Mitigation Plan* and pre-approved it (dated, November 13, 2023) contingent upon this official adoption of the participating government and entities;

Whereas, the NHMP is comprised of two main elements: Basic Plan and Appendices, collectively referred to herein as the NHMP; and

Whereas, the NHMP is in an on-going cycle of development and revision to improve it's effectiveness.

NOW, THEREFORE, THE CITY COUNIL OF THE CITY OF SALEM, OREGON, RESOLVES AS FOLLOWS:

Section 1. The City of Salem adopts *the City of Salem Natural Hazards Mitigation Plan* (Exhibit A).

Section 2. The City Manager is directed to develop, approve, and implement the mitigation strategies and any administrative changes to the NHMP.

Section 3. The City Manager is further directed to submit this Resolution to the Oregon Office of Emergency Management and Federal Emergency Management Agency, Region X officials to enable final approval of the *City of Salem Natural Hazards Mitigation Plan*.

Section 4. This resolution is effective upon adoption.

ADOPTED by the City Council the 27th day of November, 2023

ATTEST:

Amy Johnson

Deputy City Recorder

Approved by City Attorney: ______________

Checked by: B. Carrara (DC of Admin Services - Fire)

RESOLUTION NO. 2023-36

A RESOLUTION ADOPTING UPDATES TO THE CITY OF SALEM NATURAL HAZARDS MITIGATION PLAN

Adopted: November 27, 2023
Effective: November 27, 2023
Copy to:

Council Vote	Yes	No
Mayor Hoy	X	
Stapleton (Ward 1)	X	
Nishioka (Ward 2)	X	
Phillips (Ward 3)	X	
Gwyn (Ward 4)	X	
Gonzalez (Ward 5)	X	
Hoy (Ward 6)	X	
Nordyke (Ward 7)	X	
Varney (Ward 8)	X	

*A = Absent

FEDERAL EMERGENCY MANAGEMENT AGENCY APPROVAL

U.S. Department of Homeland Security
FEMA Region 10
130 228th Street, SW
Bothell, WA 98021-8627

FEMA

January 4, 2024

Chris Hoy, Mayor
City of Salem
555 Liberty St. SE, Room 100
Salem, Oregon 97301

Reference: Approval of the City of Salem Local Hazard Mitigation Plan

Dear Mayor Hoy:

In accordance with applicable[1] laws, regulations, and policy the United States Department of Homeland Security's Federal Emergency Management Agency (FEMA) Region 10 has approved the City of Salem local hazard mitigation plan. The approval period for this plan is from December 5, 2023, through December 4, 2028.

An approved mitigation plan is one of the conditions for applying for and receiving FEMA mitigation grants from the following programs:

- Hazard Mitigation Grant Program,
- Hazard Mitigation Grant Program Post-Fire,
- Building Resilient Infrastructure and Communities,
- Flood Mitigation Assistance.

Based on FEMA's review, the plan did not include all dam risk. Thus, the city is not eligible for assistance from the High Hazard Potential Dams Grant Program. If the city has High Hazard Potential Dams and is interested in this assistance, they should contact the FEMA regional mitigation planner listed below to learn more about how to include all dam risks in the plan.

Having an approved mitigation plan does not mean that mitigation grant funding will be awarded. Specific application and eligibility requirements for the programs listed above can be found in each FEMA grant program's respective policies and annual Notice of Funding Opportunities, as applicable.

To avoid a lapsed plan, the next plan update must be approved before the end of the approval period, including adoption by the participating jurisdiction(s). Before the end of the approval period, please allow sufficient time to secure funding for the update, including the review and approval process.

[1] Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended; the National Flood Insurance Act of 1968, as amended; and National Dam Safety Program Act, as amended; 44 CFR Part 201, Mitigation Planning; and Local Mitigation Planning Policy Guide (FP-206-21-0002).

Please include time for any revisions, if needed, and for your jurisdiction to formally adopt the plan after the review, if not adopted prior to submission. This will enable you to remain eligible to apply for and receive funding from FEMA's mitigation grant programs with a mitigation plan requirement. Local governments, including special districts, with a plan status of "Approvable Pending Adoption" are not eligible for FEMA's mitigation grant programs with a mitigation plan requirement.

We look forward to discussing options for implementing this mitigation plan. If you would like to do so, please contact Erin Cooper, Hazard Mitigation Planning Section Chief, at 202-856-1927 or erin.cooper@fema.dhs.gov.

Sincerely,

Kristen Meyers, Director
Mitigation Division

Enclosures

cc: Anna Feigum, Oregon Department of Emergency Management

EC:vl

SALEM
NATURAL HAZARDS MITIGATION PLAN

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VOLUME I:
BASIC PLAN

SECTION I: INTRODUCTION

City of Salem developed and updated this *2023 City of Salem Natural Hazards Mitigation Plan* (*2023 Salem NHMP* or *Salem NHMP*), in collaboration with Oregon Department of Land Conservation and Development (DLCD), to prepare for the long-term effects resulting from natural hazards. This section provides a general introduction to natural hazard mitigation planning. 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?

The Federal Emergency Management Agency (FEMA) defines hazard mitigation as "…any sustained action taken to reduce or eliminate long-term risk to life and property from hazards."

Hazards mitigation uses long and short-term strategies and actions to reduce the potential effects of hazards on the lives, property, and critical infrastructure and facilities in a community. This can be achieved through **local plans and regulations**, such as adjustments to land use designation within floodplains; **structure and infrastructure projects**, such as seismic retrofits to critical facilities; **natural systems projection and nature-based solutions** such as wetland restoration and preservation, and **education and awareness programs**, such as presentations to neighborhood organizations.

Natural hazard mitigation is the responsibility of the "whole community," which includes individuals and families; businesses; faith-based and community organizations; nonprofit groups; schools and academia; media outlets; and all levels of government, including state, local, tribal, territorial, and federal partners to prepare their community for threats and hazards. Taking the whole community approach to planning, in which all parts of the community are engaged and empowered in the development and implementation of a NHMP is a guiding principle to the process. This process positions the planning team to better understand and comprehensively approach the actual needs of a community. To work well, this approach requires a diverse array of community members at the table.

Engaging in mitigation activities provides community with several benefits, including reduced loss of life, property, essential services, critical facilities and economic hardship; reduced short-term and long-term recovery and reconstruction costs; increased cooperation and communication within the community through the planning process; and increased potential for state and federal funding for recovery and reconstruction projects.

Why Develop a Mitigation Plan?

Salem developed this NHMP in an effort to reduce future loss of life and damage to property resulting from natural hazards. It is impossible to predict exactly when natural hazard events will occur, or the extent to which they will affect community assets. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from natural hazards.

In addition to establishing a comprehensive community-level mitigation strategy, the 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 city will remain eligible for pre- and post-disaster mitigation project grants.

What Federal Requirements Does This Plan Address?

DMA2K is the latest federal legislation addressing mitigation planning. It reinforces the importance of mitigation planning and emphasizes planning for natural hazards before they occur. As such, this Act established the Pre-Disaster Mitigation (PDM) grant program, which has become the Building Resilient Infrastructure and Communities (BRIC) program, and requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP).

Section 322 of the Act specifically addresses mitigation planning at the state and local levels. State and local jurisdictions must have approved mitigation plans in place in order to qualify to receive post-disaster HMGP funds. Mitigation plans must demonstrate that the proposed mitigation actions are based on a sound planning process that accounts for the risk to the individual and their capabilities. Title 44 Code of Federal Regulations (CFR), section 201.6, also requires a local government to have an approved mitigation plan in order to receive HMGP project grants.

Pursuant of Title 44 CFR, the Natural Hazard Mitigation Plan planning processes shall include opportunity for the public to comment on the plan during review. Moreover, the updated Natural Hazard Mitigation Plan shall include documentation of the public planning process used to develop the plan. The Natural Hazard Mitigation Plan update must also contain a risk assessment, mitigation strategy and a plan maintenance process that has been formally adopted by the governing body of the jurisdiction. Lastly, the Natural Hazard Mitigation Plan must be submitted to Oregon Department of Emergency Management (OEM) for initial plan review, and then it is submitted to FEMA for review and federal approval. Once FEMA provides the Approved Pending Adoption (APA) letter, the local jurisdictions must approve the NHMP. Once the local jurisdictions have provided resolutions showing the adoption of the NHMP, FEMA will send the approval letter with the dates of the NHMP approval. The approval period is for five years.

What State Requirements Does This Plan Address?

To be eligible to apply for the FEMA's financial and technical assistance provided through the Emergency Management Performance Grant (EMPG) applicants must have a current and FEMA approved local Natural Hazard Mitigation Plan. Plans under review by FEMA, or in the draft/update phase are considered as those meeting the eligibility requirements for funding consideration. EMPG funds are provided for the development of an all-hazard emergency management capability to promote preparedness, mitigation, response, and recovery.

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 (Comprehensive Plans) and implementing ordinances that are required to comply with the statewide planning goals. The 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, calls for local plans to include inventories, policies and ordinances to guide development in or away from hazard areas. Goal 7, along with other land use planning goals, has helped to reduce losses from natural hazards. Through risk identification and the recommendation of risk-reduction actions, this plan aligns with the goals of the jurisdiction's Comprehensive Plan and helps Salem 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, resources exist at the state and federal levels. Some of the key agencies in this area include the Oregon Department of Emergency Management (OEM), Oregon Building Codes Division (BCD), Oregon Department of Forestry (ODF), Oregon Department of Geology and Mineral Industries (DOGAMI), and the Oregon Department of Land Conservation and Development (DLCD).

How was the Plan Developed?

The Salem Natural Hazards Mitigation Plan Steering Committee (Steering Committee), with collaboration of DLCD staff, updated the *2017 Salem NHMP*, which expired in 2023. The *2023 Salem NHMP* is the result of a collaboration with DLCD, which led the Steering Committee through the NHMP update process. The plan holders are those organizations or jurisdictions that signed Intergovernmental Agreements (IGAs) with DLCD for the work on the NHMP; Salem is a plan holder. The Steering Committee formally convened on ten occasions via Zoom to discuss and revise the plan. Steering Committee members contributed data, maps (where applicable), and reviewed and updated the community profile, risk assessment, action items, and implementation and maintenance plan.

An open public involvement process is essential to the development of an effective plan. In order to develop a comprehensive approach to reducing the effects of natural disasters, the planning process shall include opportunity for the public, neighboring communities, local and regional agencies, as well as, private and non-profit entities to comment on the plan during review (Code of Federal Regulations). The City of Salem provided a publicly accessible project website for the general public to provide feedback on the draft NHMP via a web form. In addition, Salem provided a social media postings to encourage the public to offer feedback on the plan update. The city website continues to be a focal point for distribution natural hazard information through the use of hazard viewers, emergency alerts, and hazard preparation.

How is the Plan Organized?

Each volume of the plan provides specific information and resources to assist readers in understanding the hazard-specific issues facing city residents, businesses, and the environment. Combined, the sections interact constructively 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. This plan structure enables stakeholders to use the section(s) of interest to them.

Volume I: Basic Plan

Section 1: Introduction

The Introduction includes a plan summary which provides an overview of the FEMA requirements, planning process, and highlights the key elements of the risk assessment, mitigation strategy, and implementation and maintenance strategy. Additionally, the Introduction briefly describes the citywide mitigation planning efforts and the methodology used to develop the plan.

Section 2: Risk Assessment

Section 2 provides the factual basis for the mitigation strategies contained in Section 3. Additional information is included within Appendix C, which contains an overall description of Salem. This section includes a brief description of community sensitivities and vulnerabilities. The Risk Assessment allows readers to gain an understanding of the city's vulnerability and resilience to natural hazards.

A hazard summary is provided for each of the hazards addressed in the plan. The summary includes hazard history, location, extent, vulnerability, impacts, and probability. This NHMP addresses the following hazards:

- Air Quality
- Drought
- Earthquake
- Extreme Heat
- Flood
- Landslide
- Volcano
- Water Quality
- Wildfire
- Windstorm
- Winter Storm
- Hazardous Materials Incident

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

Section 3: Mitigation Strategy

This section documents the plan vision, mission, goals, and actions (mitigation strategy) and describes the components that guide implementation of the identified actions. Actions are based on community sensitivity and resilience factors, and the risk assessments in Section 2. Federal, state, and local mitigation activities, successes, and resources are identified in this section as well.

Section 4: Plan Implementation and Maintenance

This section provides information on the implementation and maintenance of the plan. It describes the process for prioritizing projects and includes a suggested list of tasks for updating the plan, to be completed at the semi-annual and five-year review meetings.

Volume II: Appendices

The appendices are designed to provide the users of the NHMP with additional information to assist them in understanding the contents of the mitigation plan and provide them with potential resources to assist with plan implementation.

Appendix A: Action Items

This appendix contains the detailed action item forms for each of the mitigation strategies identified in this Plan. Appendix A-1 includes the priority actions for the city, while Appendix A-2 provides a listing of the non-priority actions. Appendix A-3 is a blank action item form to be used as new actions are identified.

Appendix B: Planning and Public Process

This appendix includes documentation of all the citywide public processes utilized to develop the plan. It includes invitation lists, agendas, sign-in sheets, and summaries of Steering Committee meetings as well as any other public involvement methods.

Appendix C: Community Profile

The community profile describes the city from several perspectives to help define and understand the city'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 D: 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 E: Grant Programs and Resources

This appendix lists federal, state, and local resources and programs.

Appendix F: Lifeline Sector Assessment

This appendix describes the findings from the 2016 Marion County Lifeline Sector Assessment. In 2015, a University of Oregon Community Planning Workshop student team assessed lifeline sectors identified by Marion County – transportation, energy, communication, and water. The assessment focused on review of each sector's adaptive capacity and vulnerabilities, as well as critical interdependencies.

Appendix G: DOGAMI Multi-Hazard Risk Report for Marion County, Oregon

Appendix G contains the Oregon Department of Geology and Mineral Industries (DOGAMI) risk assessment for the communities of Marion County, Oregon. Although the City of Salem is in both Marion and Polk Counties, the DOGAMI report examines the city in its entirety. This appendix contains the full report excerpted within the NHMP.

Appendix H: OCCRI Future Climate Projections Marion County, Oregon, OCCRI

This appendix contains Oregon Climate Change Research Institute (OCCRI) analysis of the influence of climate change on natural hazards. Although a small portion of Salem is in Polk County, OCCRI has not executed a Future Climate Projections report for Polk County. Based on the commonality between the two counties when it comes to current and future climate projections, this NHMP relies on the Marion County report issued in June 2022. This appendix contains the full report excerpted within the NHMP.

Appendix I: Acronyms

This appendix includes common state and federal acronyms.

Appendix J: References

All cited material found in the *2023 Salem NHMP* are listed in this appendix.

Appendix K: Resolution of Approval and FEMA Review Tool

This appendix includes the Salem City Council resolution of approval of the NHMP. It also includes the FEMA Review Tool for the plan.

SECTION 2: RISK ASSESSMENT

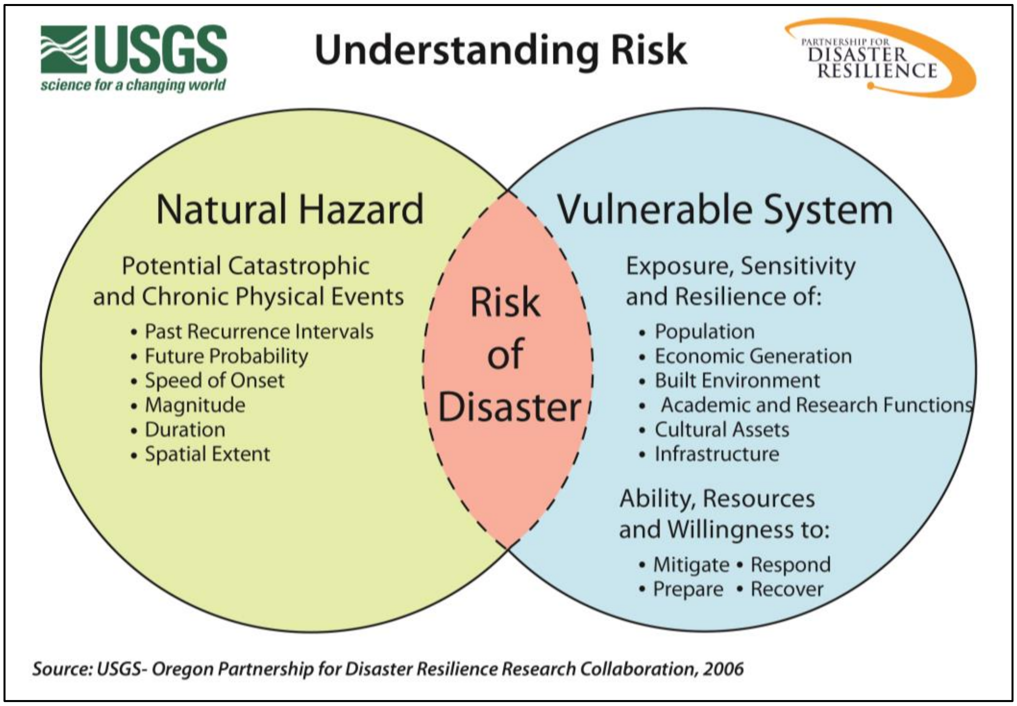
This section serves as the factual basis for City of Salem to address Oregon Statewide Planning Goal 7 – Areas Subject to Natural Hazards. In addition, this section of the NHMP addresses 44 CFR 201.6(b)(2) - Risk Assessment. Assessing natural hazards risk has three primary phases:

- **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.

This section provides information on the natural hazard risk assessment process. It is general in scope and provides information on what a risk assessment entails, describes the sources of information and risk assessment exercise used to assess risk of natural hazard events in the City of Salem, and some of the related hazard vulnerability maps that are included in the natural hazard sections. The OEM Hazard Vulnerability Assessment exercise allowed the Steering Committee to identify and evaluate the natural hazards that pose the greatest risk to the City of Salem and to evaluate the risk of each of those based on four factors (history, probability, vulnerability, and maximum threat).

The information presented below, along with hazard specific information presented with each Hazard and community characteristics presented in the Community Profile (Volume II: Appendix C) will be used as the local level rationale for the risk reduction actions identified in the Mitigation Strategy (Volume I: Section 3). The risk assessment process is graphically depicted in Figure 1. The goal of hazard mitigation is to reduce the area where hazards and vulnerable systems overlap.

Figure 1 Understanding Risk

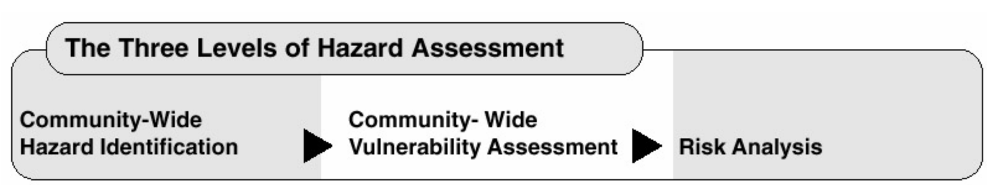


Source: Institute for Policy Research and Engagement.

Risk Assessment Approach

According to the FEMA Local Mitigation Planning Handbook, risk assessment is a product or process that collects information and assigns values to risks for the purpose of informing priorities, developing, or comparing courses of action, and informing decision making. Conducting a risk assessment can provide information on the location of hazards, the value of existing 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 primary levels: hazard identification, vulnerability assessment, and risk analysis. The Salem NHMP identifies a fourth level that includes consideration of how development trends affect risk assessments.

Figure 2 Three Levels of a Risk Assessment



Source: Oregon Department of Land Conservation and Development, 2020

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. These three levels, together with the fourth component Salem added, are described below.

Hazard Identification

Hazard identification involves the identification of the geographic extent of a hazard, its intensity, and its probability of occurrence. This level of assessment typically involves producing a map. The outputs from this phase can also be used for land use planning, management, and regulation; public awareness; defining areas for further study; and identifying properties or structures appropriate for acquisition or relocation (Burby, 1998).

The hazard identification includes a profiling of hazard events, which describes the causes and characteristics of each natural hazard, how each has affected Salem in the past, and what part of Salem's population, infrastructure, and environment has historically been vulnerable to each specific hazard. A full profile of each hazard discussed in this plan is provided in hazard section, including a full description of the history of hazard-specific events.

In the *2017 Salem NHMP*, the city identified 10 major hazards that consistently affect this geographic area: drought, earthquake, extreme heat, flood, hazardous materials incident, landslide, volcano, wildfire, windstorm, and winter storm. During the NHMP update process in 2022, the Steering Committee members identified two additional natural hazards, Air Quality and Water Quality.

Another change made to the list of natural hazards addressed in the plan was the reconsideration of the impact of Climate Change. The Steering Committee agreed that the impact of climate change is experienced in the increased severity and frequency of natural hazard events and will be addressed throughout the NHMP.

Vulnerability Assessment

The vulnerability assessment combines the information from the hazard identification with an inventory of the existing (or planned) property and population exposed to a hazard and attempts to predict how different types of property and population groups will be affected by the hazard. This step can also assist in justifying changes to building codes or development regulations, property acquisition programs, policies concerning critical and public facilities, taxation strategies for mitigating risk, and informational programs for members of the public who are at risk. (Burby, 1998)

The critical facilities have been identified, listed in a table at the end of this section and noted, where applicable, in each identified hazard.

Risk Assessment/Analysis

The risk assessment/analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment, and (2) the likelihood or probability of the harm occurring.

The following risk analysis draws upon four sources: *2017 Salem NHMP*, Hazard Vulnerability Assessment exercise conducted with Salem NHMP Steering Committee using the method developed by FEMA Region X and Oregon Department of Emergency Management (OEM), and the list of Local Essential and State-owned and Leased Properties for Marion and Polk

Counties contained within the *2020 Oregon NHMP*. This list was evaluated and revised by the Salem Steering Committee to develop the list provided in Table 23 of critical and essential facilities. The value and area of these structures comprises the data used to estimate potential losses.

The fourth source of information for the risk analysis is the DOGAMI Multi-Hazard Risk Report that utilizes HAZUS-MH analysis and geospatial analysis for Marion County and the western portion of Salem that is in Polk County. HAZUS-MH stands for Hazards U.S. – Multi-Hazard and it is a software program that joins current scientific and engineering knowledge with the latest geographic information systems (GIS) technology to produce estimates of hazard-related damage before, or after a disaster occurs. The geospatial analysis includes both loss estimates (in dollars) to buildings from flood (recurrence intervals) and earthquake scenarios using FEMA Hazus®-MH methodology, and (2) calculated number of buildings, their value, and associated populations exposed to earthquake, and flood scenarios, or susceptible to varying levels of hazard from landslides and wildfire (Williams et al., 2022).

Development Trends

Assessing vulnerability and analyzing development trends provides a general description of land uses and development trends within the community so that mitigation options can be considered in land-use planning and future land-use decisions. This plan provides a comprehensive description of the character of the Salem community in Community Profile (Volume II: Appendix C). This description includes the geography and environment, population and demographics, land use and development, housing and community development, employment and industry, and transportation and commuting patterns. Analyzing these components of the Salem community can help in identifying potential problem areas and can serve as a guide for incorporating goals and ideas contained in this mitigation plan into other community development plans.

Hazard assessments are subject to the availability of hazard-specific data. Gathering data for a hazard assessment requires a commitment of resources on the part of participating organizations and agencies. Each hazard-specific section of the plan includes a section on hazard identification using data and information from city, county, or state agency sources.

Regardless of the data available for hazard assessments, there are numerous strategies the City of Salem can take to reduce risk. These strategies are described in the action items detailed in Section 3 of this plan. Mitigation strategies can further reduce disruption of critical services, reduce the risk to human life, and alleviate damage to personal and public property and infrastructure. Action items provide recommendations to collect further data to map hazard locations and conduct hazard assessments.

NHMP Planning Area

44 CFR 201.6(c)(2)(iii) – Multi-jurisdictional Risk Assessment: The Risk Assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area . . .

This is not a multi-jurisdictional NHMP; the only plan holder for this NHMP is City of Salem. A plan holder is a partner that is a jurisdiction that signs the IGA with DLCD for the work on the NHMP. The planning area for the *2023 Salem NHMP* is the City of Salem. There are other partners that participated on the *2023 Salem NHMP,* but they did not sign an IGA with

DLCD. All partners are listed in the Special Thanks and Acknowledgements section of the *2023 Salem NHMP*. There are maps throughout the NHMP that illustrate the location of Salem with reference to Marion County or Polk County and Oregon. In addition, there are maps of Salem in detail.

Hazard Identification and Assessment

Salem identifies 11 natural hazards that could impact the city. These hazards include air quality, drought, earthquake, extreme heat, flood, landslide, volcanic event, water quality, wildfire, windstorm, and winter storm. At the Salem NHMP Steering Committee meeting on November 15, 2022 and December 14, 2022, the DLCD Natural Hazards Planner led the group in an exercise called the Hazard Vulnerability Analysis or Assessment (HVA). At the January 26, 2023 Steering Committee meeting, the HVA was reviewed and revised. The results are discussed in more detail later in this Risk Assessment.

Table 1 categorizes the hazards identified by Salem and compares it to the regional hazards identified in the *2020 Oregon Natural Hazard Mitigation Plan* for the Mid/Southern Willamette Valley Region (Region 3). Region 3 includes Linn, Lane (non-coastal), Marion, Polk, and Yamhill Counties.

Table 1 Salem Hazard Identification Comparison

Salem	Marion County	Oregon NHMP Region 3: Mid/Southern Willamette Valley
Natural Hazards		
Air Quality	N/A	N/A
Drought	Drought	Drought
Earthquake	Earthquake	Earthquake
Extreme Heat	Extreme Heat/ High Temperature	Extreme Heat
Flood	Flood	Flood
Landslide	Landslide	Landslide
Water Quality	N/A	N/A
Wildfire	Wildland Interface Fire	Wildfire
Windstorm	N/A	Windstorm
Winter Storm	Severe Weather/Storm (winter)	Winter Storm
N/A	Avalanche	N/A
Volcano	N/A	Volcano
Other Hazards		
Hazardous Materials Incident	Hazardous Materials*	

Source: Salem NHMP Steering Committee, 2022-2023 ; Marion County NHMP, 2022; *2020 Oregon NHMP*
*Note: Marion County 2022 NHMP identified multiple non-natural hazards including hazardous materials.

This Hazard Identification section includes descriptions for each natural hazard in the following ways: significant changes since the *2017 Salem NHMP*, characteristics, and the location/extent. The hazard identification also includes profiling of hazard events, which describes the causes and characteristics of each natural hazard, how each has affected Salem in the past, and what part of Salem's population, infrastructure, and environment has historically been vulnerable to each specific hazard. For additional details on the history of events for each hazard, the relationship with climate projections, and maps of the hazards, see below under Hazard Characterization.

As part of the NHMP update process, there is a requirement to examine changes in development. Climate change and climate resilience are important parts of this discussion. The climate is changing and the impacts becoming more evident in both quantitative and qualitative information. According to the UN Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2014: Mitigation of Climate Change*, resilience is defined as “the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (Arctic Council, 2013).” (Allwood et al., 2014).

The Hazard Vulnerability Assessment and the analysis of risk are included within and after the Hazard Identification section of this Risk Assessment. This analysis covers all the identified natural hazards in a relatively brief manner. Other hazards such as hazardous materials incident was not reviewed. Note that Table 23 Critical and Essential Facilities for the City of Salem, identifies the critical facilities, critical infrastructure, and vulnerable population centers of Salem.

Of the *2020 Oregon Natural Hazards Mitigation Plan*, Region 3 includes Linn, Lane (non-coastal), Marion, Polk, and Yamhill Counties. As described in the Risk Assessment for Region 3, Climate Change section:

> The hazards faced by Region 3 that are projected to be influenced by climate change include drought, wildfire, flooding, landslides, and extreme heat.
>
> Climate models project warmer, drier summers for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, Region 3 is expected to be affected by an increased incidence of drought and wildfire. In Region 3, climate change would result in increased frequency of drought due to low spring snowpack (very likely, >90%), low summer runoff (likely, >66%), and low summer precipitation and low summer soil moisture (more likely than not, >50%). It is very likely (>90%) that Region 3 will experience increasing wildfire frequency and intensity due to warmer, drier summers coupled with warmer winters that facilitate greater cold-season growth.
>
> It is extremely likely (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (very high confidence).
>
> Furthermore, flooding and landslides are projected to occur more frequently throughout western Oregon. It is very likely (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (high confidence) that is more likely than not (>50%) to lead to an increase in the incidence and magnitude of damaging floods (low confidence). Because landslide risk depends on a variety of site-specific factors, it is more likely than not (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.
>
> While winter storms and windstorms affect Region 3, there is little research on how climate change influences these hazards in the Pacific Northwest. For more

information on climate drivers and the projected impacts of climate change in Oregon, see Section 2.2.1.2.

Federal Disaster and Emergency Declarations

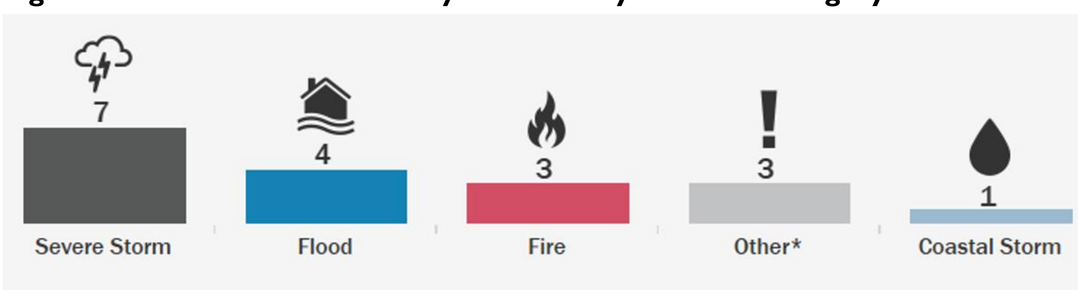
Reviewing past events that have occurred in Salem and Marion and Polk Counties can provide a general sense of the hazards that have caused significant damage in the city and surrounding area. Where trends emerge, disaster declarations can help inform hazard mitigation project priorities.

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. When governors ask for presidential declarations of major disaster or emergency, they stipulate which counties in their state they want included in the declaration.

A Major Disaster Declaration provides a wide range of federal assistance programs for individuals and public infrastructure, including funds for both emergency and permanent work. 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. Fire Management Assistance is provided after a State submits a request for assistance to the FEMA Regional Director at the time a "threat of major disaster" exists.

According to FEMA's Disaster Declarations for States and Counties, FEMA has approved a total of 39 federal major disaster (DR) declarations in Oregon, as of February 2023. In addition, there have been 4 emergency (EM) declarations and 99 fire management assistance (FM) declarations in Oregon as of February 2023. There are also 36 Fire Suppression Authorizations (FSA) on record for Oregon. Counting primary types of disaster declarations (DR, EM, and FM), the total number of disasters in Oregon is 142.

Figure 3 Marion and Polk County Disasters by Incident Category



Source: Federal Emergency Management Agency, 2021

Figure 1, shown above, uses FEMA's historical disaster data information as a visual for the disaster declarations in Marion and Polk Counites. Salem is in Marion County and Polk County. Of the 142 Oregon declarations, Marion and Polk Counties are associated with 18 of those declarations, which include 14 DR, 3 EM, and 1 FM declarations. Table 2 summarizes the FEMA disaster declarations declared in Oregon that have directly affected Marion and Polk Counties since 1953; this table uses the FEMA disaster declarations information as noted in the source listed under the table.

Table 2 FEMA Major Disaster, and Emergency, and Fire Management Assistance Declarations for Marion and Polk Counties

Declaration Number	Declaration Date	Incident Period From	Incident Period To	Incident	Individual Assistance	Public Assistance Categories
DR-184	12/24/1964	12/24/1964	12/24/1964	Heavy rains and flooding	Yes	A, B, C, D, E, F, G
DR-413	1/25/1974	1/25/1974	1/25/1974	Severe Storms, Snowmelt, Flooding	Yes	A, B, C, D, E, F, G
DR-985^	4/26/1993	3/25/1993	3/25/1993	Earthquake	Yes	A, B, C, D, E, F, G
DR-1099	2/9/1996	2/4/1996	2/21/1996	Severe Storms/Flooding	Yes	A, B, C, D, E, F, G
DR-1510	2/19/2004	12/26/2003	1/14/2004	Severe Winter Storm	None	A, B, C, D, E, F, G
EM-3228	9/7/2005	8/29/2005	10/1/2005	Hurricane Katrina Evacuation	None	B
DR-1632*	3/20/2006	12/18/2005	1/21/2006	Severe Storms, Flooding, Landslides, and Mudslides	None	A, B, C, D, E, F, G
DR-1683*	2/22/2007	12/14/2006	12/15/2006	Severe Winter Storm and Flooding	None	A, B, C, D, E, F, G
DR-1733*	12/8/2007	12/1/2007	12/17/2007	Severe Storms, Flooding, Landslides, and Mudslides	None	A, B, C, D, E, F, G
DR-1824	3/2/2009	12/13/2008	12/26/2008	Severe Winter Storm, Record and Near Record Snow, Landslides, and Mudslides	None	A, B, C, D, E, F, G
DR-4055	3/2/2012	1/17/2012	1/21/2012	Severe Winter Storm, Flooding, Landslides, and Mudslides	None	A, B, C, D, E, F, G
DR-4258*	2/17/2016	12/6/2015	12/23/2015	Oregon Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides	None	A, B, C, D, E, F, G
EM-3429	3/13/2020	1/20/2020	Ongoing	Oregon Covid-19	None	B
DR-4499	3/28/2020	1/20/2020	Ongoing	Oregon Covid-19 Pandemic	Yes	B
FM-5356^	9/8/202	9/7/2020	10/15/2020	Oregon Beachie Creek Lionshead Complex	None	B, H

Declaration Number	Declaration Date	Incident Period		Incident	Individual Assistance	Public Assistance Categories
		From	To			
EM-3542^	9/10/2020	9/8/2020	9/15/2020	Oregon Wildfires	None	B
DR-4562^	9/15/2020	9/7/2020	11/3/2020	Oregon Wildfires, Straight-line Winds	Yes	A, B, C, D, E, F, G
DR-4599	5/4/2021	2/11/2021	2/15/2021	Oregon Severe Winter Storms	None	A, B, C, D, E, F, G

Source: Federal Emergency Management Agency, 2021Note: ^-Declared for Marion County Only, *-Declared for Polk County Only

Air Quality

Significant Changes Since Previous Plan:

The Air Quality Hazard is new to Salem's NHMP.

Causes and Characteristics

Communities across Oregon have begun to recognize the impacts of inversion layers trapping particulates in smoke from wood stove, prescribed fire, wildfire, and field burning as a natural hazard. In addition, Salem has begun to recognize the impacts of reduced outdoor air quality with warmer temperatures and increase in the number and size of wildfires in the region.

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.

The Oregon Climate Change Research Institute's *Future Climate Projections Marion County, Oregon* report (June 2022) discusses how fire seasons have increased in length over the past several decades. The fires have also increased in intensity and severity. Wildfires that have occurred in the western United States have created extensive plumes of smoke, which travel at high altitudes over long distances. This can affect air quality near and far from a wildfire site. The report states, "This trend is expected to continue as a result of complex factors including traditional forest management practices, increasing population density in fire risk zones, and climate change (Sheehan et al., 2015)." (Dalton et al., 2022)

Air quality can be affected by several types of pollutants including ozone, particulate matter, air toxics (such as benzene), greenhouse gases (such as carbon dioxide), and products of combustion (such as carbon monoxide, sulfur dioxide and NOx). Among these, particulate matter with particles 2.5 microns or smaller (PM2.5) is the pollutant of highest concern in Salem.

Wildfires[1] 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. If a volcano[2] were to erupt, ashfall could inundate the surrounding areas sufficiently to impact transportation and cause widespread health concerns.

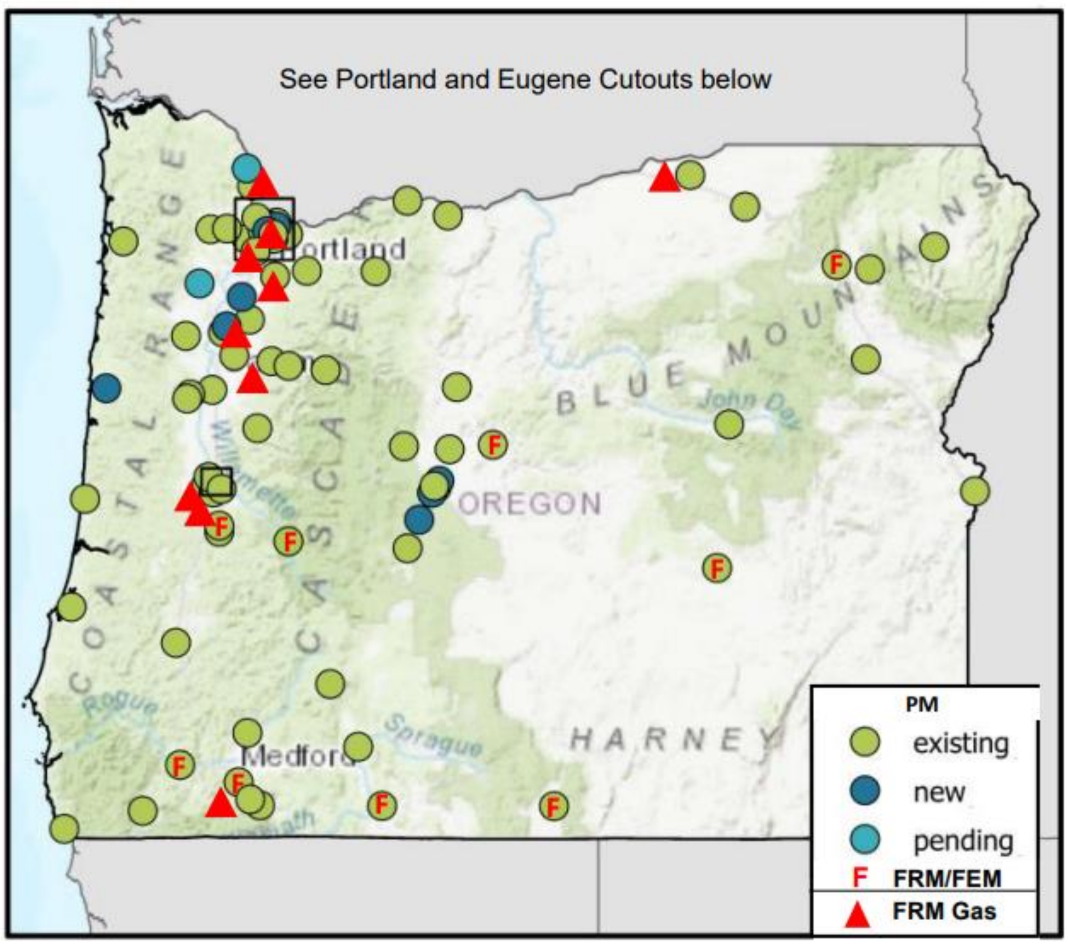
[1] See the Wildfire Hazard for more information about wildfire impacts.

[2] See the Volcano hazard for more information about volcano impacts.

Location and Extent

According to the *2022 Oregon Annual Ambient Criteria Pollutant Air Monitoring Network Plan* issued by DEQ, air quality pollutants are currently monitored at various locations in the Salem area including at the Salem State Hospital, Chemeketa Community College's Salem campus, and Cascade Junior High School in Turner. Poor Air Quality has seasonality in that inversion layers tend to form from November to February. Once air temperatures warm the inversion layer conditions dissipate. During the summer months from June through August high pressure weather systems can remain in place for an extended period resulting in the accumulation of airborne particles in the lower levels of the atmosphere affecting the air quality. In addition, smoke from surrounding fires could impact Salem and affect the air quality prompting Air Stagnation Advisories (Dalton et al., 2022). Figure 4 shows the 2022 Ambient Air Monitoring Network sites in Oregon. In addition, Figure 8 shows the types of air quality monitoring station in and around Salem.

Figure 4 Oregon 2022 Ambient Air Monitoring Network (DEQ and LRAPA sites)



Source: Oregon Department of Environmental Quality, 2022
Note: Portland metro and Eugene metro cutouts are not shown here.

Air Quality Pollutants

Oregon DEQ monitors air quality pollutants. DEQ operates the ambient monitoring network for the entire state, except Lane County, which is operated by the Lane Regional Air Protection Authority (LRAPA). These air quality monitoring networks measure ambient concentrations of the criteria pollutants – ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead. Air quality pollutants are currently monitored at various locations in the Salem area, according to DEQ's *2022 Oregon Annual Ambient Criteria Pollutant Air Monitoring Network Plan,* including at the Salem State Hospital, Chemeketa Community College's Salem campus, and Cascade Junior High School in Turner.

Ozone

DEQ's *Oregon Air Quality Monitoring Annual Report: 2020 (2021)* describes the following:

> Ozone is a secondary pollutant formed when there are elevated levels of nitrogen dioxide and volatile organic compounds 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, which contains NO2 and VOCs. In 2017 and 2018, most of the state experienced elevated ozone because the wildfire smoke introduced natural precursors on top of the human-caused emissions.

Data with wildfire contributions are included because it is very difficult to determine if the ozone would have exceeded the NAAQS without the smoke from wildfires.

The *Oregon Air Quality Monitoring Annual Report: 2020* continues, "Data with wildfire contributions are included because it is very difficult to determine if the ozone would have exceeded the NAAQS without the smoke from wildfires." Additionally, it is noted that the wildfire smoke in 2018 and 2020 contributed to the elevated ozone levels, which likely caused Portland and Medford to violate the NAAQS. However, it is very difficult to determine what the ozone level would have been since high levels typically occur in the summer months, "precisely when wildfire smoke impacts occur."

The *2022 Oregon Annual Ambient Criteria Pollutant Air Monitoring Network Plan* describes the 10 DEQ and LRAPA monitoring sites for ozone. There are two of these monitoring sites in or near Salem at the Salem State Hospital and Cascade Junior High School in Turner.

$PM_{2.5}$

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.

The Future Climate Projections report issued in June 2022 for Marion County's NHMP update stated 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 wave" days. "Smoke wave" days are two or more consecutive days with high levels of $PM_{2.5}$ from wildfires (Dalton et al., 2022).

DEQ notes that it is useful to understand how much wildfire smoke contributed to particulate levels above the NAAQS standard, because this shows the effectiveness of local air quality improvement in communities with particulate reduction plans to promote such actions as wood stove efficiency programs.

There are harmful effects from breathing particles measuring less than 10 microns in diameter (PM_{10}). Fine particle matter $PM_{2.5}$ may be responsible for the most significant health effects, like premature mortality, hospital admissions, and respiratory illness. These particles can be inhaled deeply into the lungs where they enter the bloodstream or can remain for years. The health effects of particulate matter vary with the size, concentration, and chemical composition of the particle, according to the EPA.

PM_{10}

In the *Oregon Air Quality Monitoring Annual Report: 2020* (2021), the PM_{10} trend chart shows the values in cities with the highest average, concentration, and lowest concentrations. All cities are well below the standard, but EPA requires DEQ to continue monitoring in PM_{10} maintenance areas and in cities over 500,000 people.

Carbon Monoxide, Sulfur Dioxide, Nitrogen Dioxide

Carbon monoxide was above the standard in the Portland Metro area for three days during the wildfire impacts. Otherwise, for the rest of the year carbon monoxide, sulfur dioxide, and nitrogen dioxide [met] federal health standards. These pollutants, according to the *Oregon Air Quality Monitoring Annual Report: 2020* (2021), have been trending mostly downward for most locations over the last ten years.

Air Toxics

DEQ and LRAPA began sampling for air toxics in Oregon in 1999. This section of the *Oregon Air Quality Monitoring Annual Report: 2020* (2021) describes data for the toxics, or hazardous air pollutants, of concern: benzene, tetrachloroethylene, acetaldehyde, formaldehyde, naphthalene, arsenic, cadmium, chromium, lead, manganese, and nickel. According to the annual report, the values are compared to the Oregon ambient concentration health benchmarks. These benchmarks are the levels where people exposed for a lifetime have an additional one in a million risk of cancer or of experiencing non-cancer health effects. The information provided in the report is for neighborhood monitoring only and does not include monitoring next to industrial facilities. Information regarding monitoring next to industrial facilities is presented in separate reports issued by the Oregon Health Authority, specific to the monitoring project and facility.

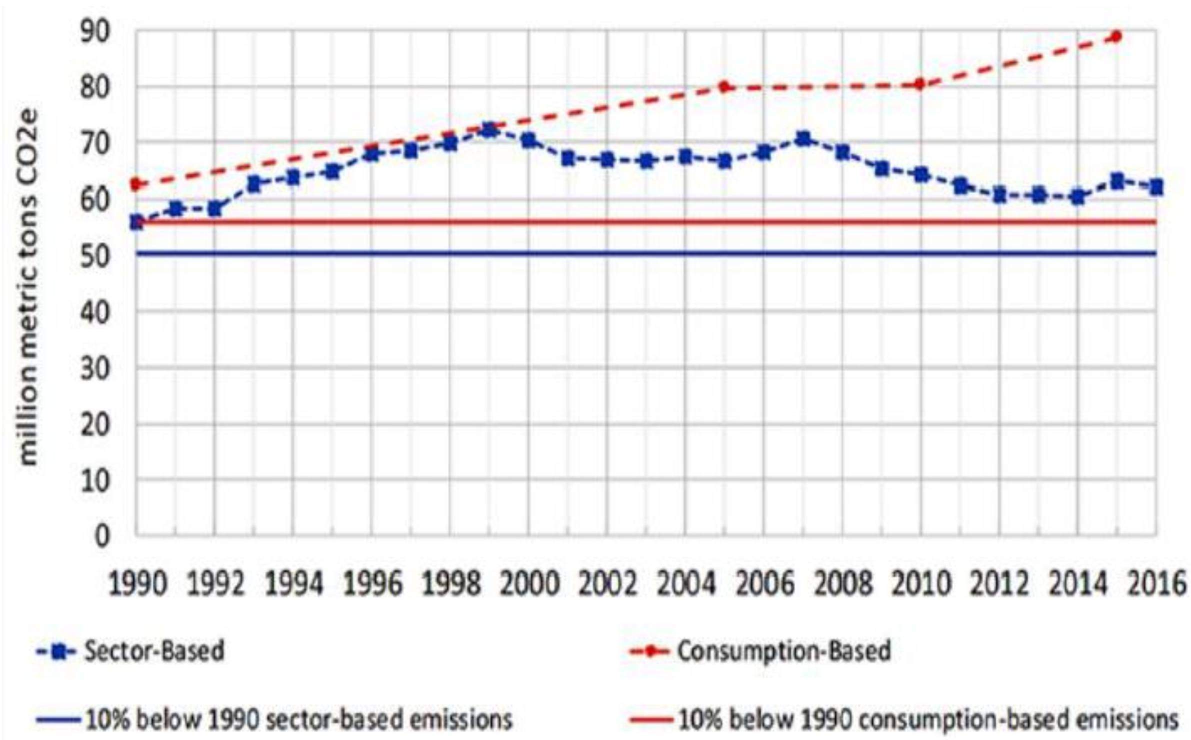
Greenhouse Gases

Greenhouse gas emissions are produced directly from activities such as driving cars and heating homes. Indirectly, greenhouse gas emissions are indirectly contributed to when electricity, goods or food is purchased or manufactured in other states or countries. Oregon DEQ divides statewide greenhouse gas emissions into two categories: sector-based and consumption-based.

According to the *Oregon Air Quality Monitoring Annual Report: 2020* (2021), sector-based emissions are “produced in Oregon from transportation, residential, commercial, industrial, and agriculture sectors, including electricity produced elsewhere but used in state” while consumption-based emissions are "produced around the world due to Oregon's consumption of energy, goods, and services." Additional information about greenhouse gas emissions in Oregon are presented on DEQ's website at https://www.oregon.gov/deq/ghgp/Pages/GHG.aspx.

Figure 5 is excerpted from the *Oregon Air Quality Monitoring Annual Report: 2020* (2021) report and shows Oregon's greenhouse gas emissions from 1990 through 2016 by sector. Emissions from transportation and electricity use are Oregon's largest sources of greenhouse gas emissions, as shown in Figure 5 by the *Oregon Greenhouse Gas Sector-Based Inventory Data* (n.d.).

Figure 5 Oregon total greenhouse gas emissions by sector 1990-2016



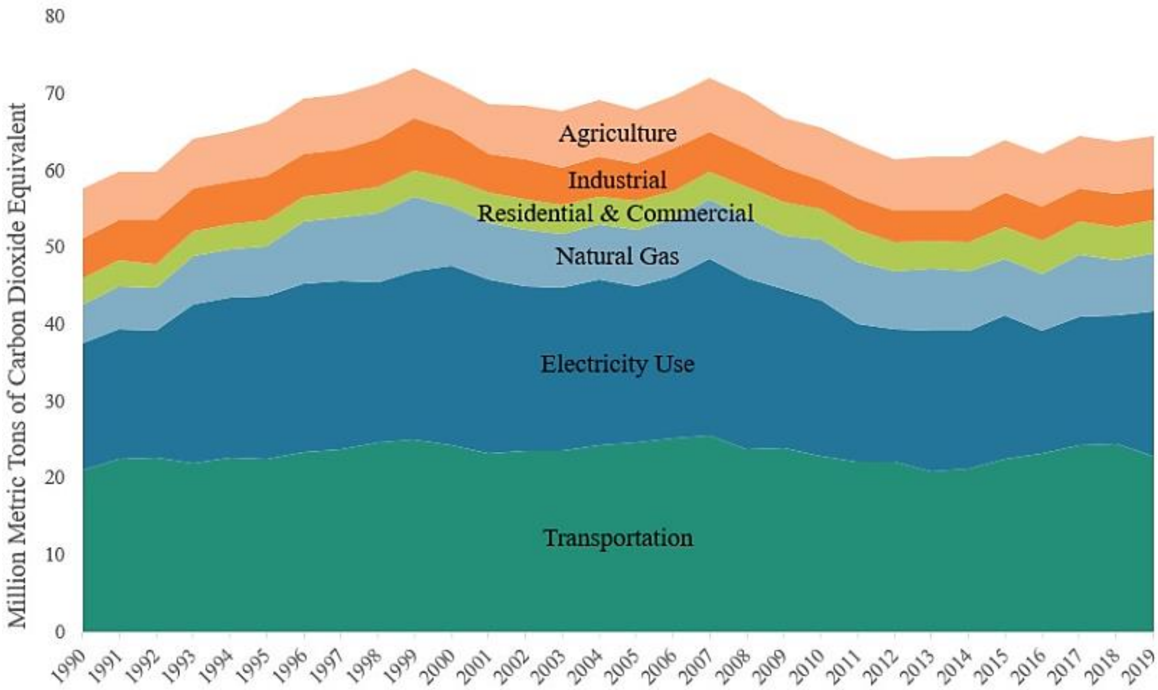
Source: Oregon Department of Environmental Quality, 2021.

Identifying Poor Air Quality

Both specific measures of components of poor air quality and a general Air Quality Index are methods for determining the quality of the air.

Standards for air quality as determined by the EPA have changed over time. In 1987 particulate matter was measured using the national PM_{10} levels as 24-hour concentrations and as average annual concentrations. The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards. In 1996 the impact of 2.5-micron particles was recognized and the national $PM_{2.5}$ 24-hour National Ambient Air Quality Standard (NAAQS) was established at 65 ug/m^3, and the annual average NAAQS set at 15 ug/m^3. In 2006 the national $PM_{2.5}$ 24-hour standard was reduced to 35 ug/m^3. In 2012 the national $PM_{2.5}$ annual average NAAQS was further reduced to 12 ug/m^3. The PM_{10} annual average was revoked.

Figure 6 Greenhouse gas emissions from 1990-2019



Source: Oregon Department of Environmental 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. The highest of the AQI values for the individual pollutants becomes the AQI value for that day. For example, if values are 90 for ozone and 88 for nitrogen dioxide, the AQI reported would be 90 for the pollutant ozone on that day. A rating of good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy, and hazardous are designated for the AQI providing a daily air quality rating (Table 3). The EPA provides all states with the AQI equation for national uniformity. DEQ and LRAPA report the AQI for cities in Oregon. The *Oregon Air Quality Monitoring Annual Report: 2020* provides a review of the health levels over the past year.

Table 3 Air Quality Index Ranges and Episode States for PM2.5 and ozone.

Air Quality Rating	Air Quality Index (AQI)	$PM_{2.5}$ 24-hour Average (µg/m³)	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: Oregon Department of Environmental Quality, 2021

According to *Oregon Air Quality Monitoring Annual Report: 2020* (2021), the air pollutants of greatest concern in Oregon were the following:

- Fine particulate matter (mostly from combustion sources) known as $PM_{2.5}$
- Air Toxics - pollutants that cause or may cause cancer or other serious health effects.
- Ground-level ozone, a component of smog.
- Greenhouse gas (GHG) emissions and global climate change are also concerns in Oregon. Oregon state agencies track GHG emissions from a wide variety of products, services, utilities, and fuel providers. These emissions data are available on DEQ's web site under Air Quality/ AQ Programs / Greenhouse Gas Reporting Home. This is an overall issue across all of Oregon but of more concern in higher population density areas.

According to the *2022 Salem Area Comprehensive Plan*, the first *Greenhouse Gas Inventory Report* was completed in 2019. The report informed the development of their first *Salem Climate Action Plan 2021* and the 2022 update to the Salem Comprehensive Plan.

The Salem *Greenhouse Gas Inventory Report* spans six emissions source categories including: mobile emissions, stationary combustion, water and wastewater, electricity generation, agriculture/urban forestry, and waste generation. The *2022 Salem Comprehensive Plan* provides this summary.

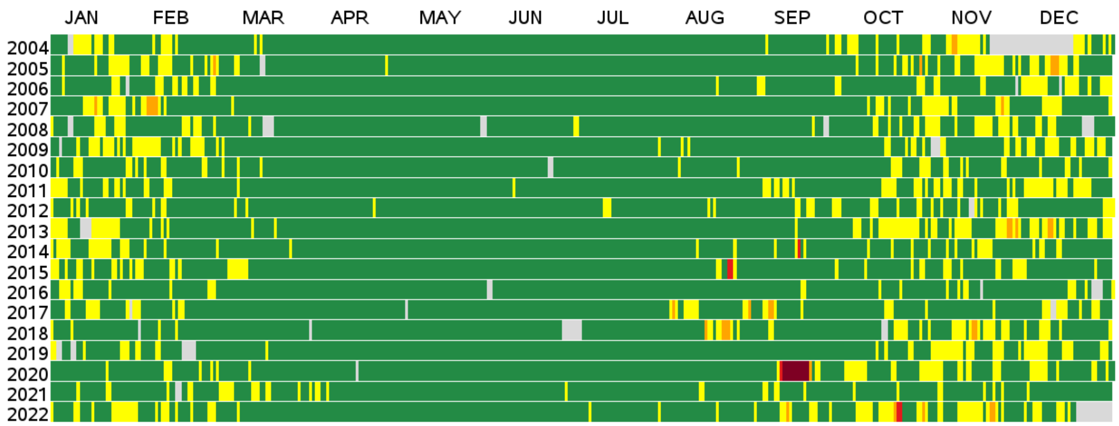
> The sector-based inventory determined that Salem's residents, businesses, employees, and visitors produced over 1.5 million metric tons of carbon dioxide equivalent (CO2e) in 2016. Of the six emissions source categories surveyed, mobile

emissions – transportation – made up more than half (53%) of the CO2e produced. Electricity generation comprised over one quarter of all emissions, while residential and commercial stationary combustion (e.g., propane and natural gas) was the third largest contributor at 16 percent.

History

The data available to track poor air quality conditions in Salem are limited to three permanent monitoring stations measuring $PM_{2.5}$. Figure 7 below shows a pattern of periods of the year where the likelihood of high levels of particulate matter of this diameter (2.5 microns) have been present at that station. One example is during the September 2020 wildfires in the region and as depicted in dark red in Figure 7, Salem experienced extremely poor air quality.

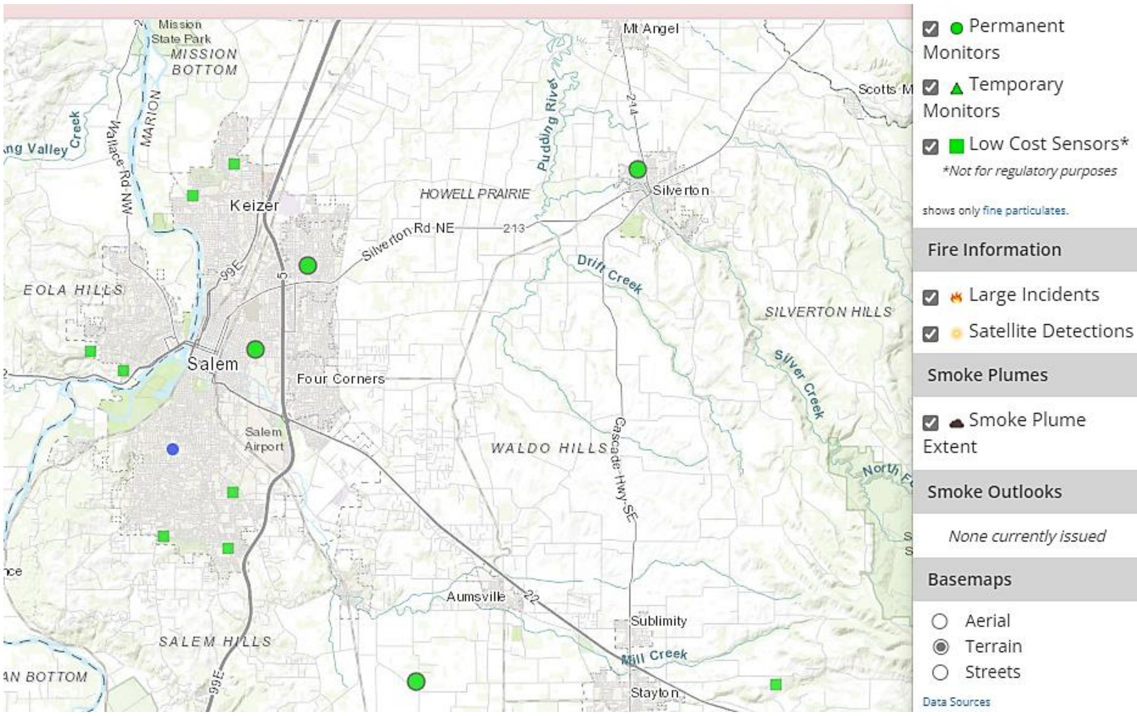
Figure 7 $PM_{2.5}$ Daily AQI Values, 2004 to 2022 for Salem, OR



Source: U.S. Environmental Protection Agency, 2023.

The EPA AirNow website maintains a real time [Fire and Smoke Map](#) for monitoring air quality and provides a tool for NHMP plan holders to use when using the plan. The figure below shows locations of both regulatory and low cost sensors not valid for regulatory purposes, but represented on the map in the interest of public health.

Figure 8 Air Quality Monitoring Station Types



Source: U.S. Environmental Protection Agency, 2023

The determination of the severity of poor air quality and collecting data demonstrating the problem may provide support for mitigation actions aimed at managing prescribed burning, reduction of 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 (AMTIC) provides information on monitoring programs and methods, quality assurance and control procedures, and federal regulations.

Future Climate Variability

The OCCRI *Future Climate Projections Marion County, Oregon* ((Dalton et al., 2022) indicates that future climate projections are for reduced 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. In Marion County, the number of "smoke wave" days is projected to increase by 18% and the intensity of those days is projected to increase by 91%.

In addition, OCCRI's report indicates that plants are responding to changes in climate and atmospheric concentrations of carbon dioxide by producing more pollen, and producing pollen earlier in spring, for longer periods of time. In the conterminous United States, pollen seasons increased by about 20 days and pollen concentration increased by 21% from 1990 through 2018. Such poor air quality is expected to exacerbate allergy and asthma conditions and increase the incidence of respiratory and cardiovascular illnesses and death.

As noted previously, Salem completed their first *Greenhouse Gas Inventory Report* in 2019, which informed the development of their first *Salem Climate Action Plan 2021* and the 2022 update to the SalemComprehensive Plan. According to city's Comprehensive Plan, the *Salem Climate Action Plan 2021* "sets the course for the City to reduce its greenhouse gas emissions and increase its resilience to climate change." The *Salem Climate Action Plan 2021* includes numerous strategies to address a variety of climate-related challenges facing the city including poor air quality as stated here,

> Salem residents will notice several changes in the climate in coming decades. The shifts in climate are projected to occur in three main areas: warming temperatures, changing precipitation patterns, and increased risk of wildfire. Some of the most significant projected climate impacts are the following:
>
> - The number of days with a heat index over 90°F will increase from a historic average of 7 per year to 33 per year by mid-century.
> - Hotter and drier conditions are likely to cause more frequent droughts.
> - More intense rainfall and rain-on-snow events could also lead to flood events in areas outside of historical high-risk zones.
> - Wildfire is a significantly increasing risk across the state of Oregon. The number of extreme fire danger days in Salem will double by mid-century, increasing from a historic average of 10 per year to 20 per year. Extremely large, intense fires will become more likely under hotter and drier climate scenarios.
> - Poor to hazardous air quality resulting from wildfires could greatly impact unsheltered populations and people with underlying health issues such as asthma, diabetes and obesity.

Probability Assessment

As previously noted, communities across Oregon have begun to recognize the impacts of inversion layers trapping particulates in smoke from wood stove, prescribed fire, wildfire, and field burning as a natural hazard. In addition, Salem has begun to recognize the impacts of reduced outdoor air quality with warmer temperatures and increase in the number and size of wildfires in the region.

Depending upon climate conditions, air stagnations can be infrequent or numerous in any given year, which can have a potential impact to air quality levels for both $PM_{2.5}$ and ozone in the area. Prevailing wind direction and strength can influence the location and extent of the air quality impacts. The probability of air quality at one level or another varies, as air quality is a range based on multiple factors such as those measured for carbon monoxide, particulate matter (PM_{10} and $PM_{2.5}$), ozone, and others described above.

The sources of air pollution in the region include wood stove, prescribed fire, wildfire, and field burning, industrial, and motor vehicle emissions. Industry and residential wood stoves emit particulate matter and carbon monoxide. Concerns for air quality arise when smoke from regional wildfires either blows through the Willamette Valley or becomes trapped during inversions. See the Wildfire Hazard for more information about wildfire impacts. In addition, climate change has a relationship with natural hazards, as noted above.

Several key points from the OCCRI *Future Climate Projections Marion County, Oregon* report are shared here:

- Wildfire risk, expressed as the average number of days per year on which fire danger is very high, is projected to increase under future climate change in Marion County.
- The average number of days per year on which vapor pressure deficit is extreme is projected to increase by 27 days (range 9–43) by the 2050s, compared to the historical baseline, under the higher emissions scenario.
- With air quality, under future climate change, the risk of wildfire smoke exposure is projected to increase in Marion and Polk Counties.
- In Marion County, the number of "smoke wave" days is projected to increase by 18% by 2046-2051 under a medium emissions scenario compared with 2004-2009.

Warmer temperatures may increase ground-level ozone concentrations. Increases in the number and size of wildfires may increase concentrations of smoke and particulate matter. Although usually thought of as being a summer occurrence, wildfires can occur during any month of the year. Many wildfires burn during June to October time, but over the years there have been more and larger fires, extending the season beyond the past years' typical periods.

As noted previously, plants also are responding to changes in climate and atmospheric concentrations of carbon dioxide by producing more pollen earlier in the spring and for longer periods of time. Lastly, the wood stove, industrial, and motor vehicle emissions can occur during any month of the year.

Based on the available data and research for Salem, the NHMP Steering Committee assessed the **probability of experiencing locally poor air quality as "high,"** meaning one incident is likely within a 10 to 35-year period.

Vulnerability Assessment

A climate-related driver of health is air quality, including pollen, wildfire smoke, smog, and ozone. Poor air quality puts the health of all persons at risk. However, people experience the impacts differently. According to OCCRI, *Fifth Oregon Climate Assessment* (2021), inequities and unequal investments in social determinants of health are contributing stress factors and include housing, education, income, wealth, transportation access, food security, income security, access to health care. The effects of poor air quality are long-term, chronic, and often difficult to trace. Those persons most at risk tend to be the elderly, very young children, and people with pre-existing respiratory problems. The OCCRI *Fifth Oregon Climate Assessment* (2021) report states,

> The health effects of climate change are strongly affected by the baseline status of individuals and communities, especially people's living conditions and pre-existing health conditions. These factors differ significantly by race, historical levels of economic investment, and level of pollution exposure. Among the individuals most susceptible are those with existing chronic conditions, older adults, pregnant women, and children (Liu et al. 2017, Hutchinson et al. 2018). People of color, people with low incomes, unhoused populations, agricultural workers, first responders, and rescue workers are those most susceptible to wildfire smoke exposure (Rudolph et al. 2018). Asthma hospitalizations in Oregon disproportionately affect Black, Pacific Islander, and Indigenous people as compared

> to other racial or ethnic groups (OHA 2018a). Exposure to smoke compounds this existing disparity.

The Salem NHMP Steering Committee is especially concerned about the increase in regional wildfire smoke and the impact it has on the community. According to NASA's *Increased Fire Comes with Increased Health Risks*, "Researchers believe recent fire seasons give a taste of the more active wildfires of the future. Such fires are likely to increase air pollution, even as emissions from industry and motor vehicles have fallen in recent decades." Furthermore, "The U.S. has really made great strides in reducing man-made particles," said study co-author Loretta Mickley of Harvard University. Mickley continues, however, "wildfires dominate poor air quality in the West." The study identifies that wildfires contribute roughly 18 percent of the total particulate emissions in the U.S.

That same study noted,

> Globally, fine particles have been linked to more than 3.3 million premature deaths…. Particulate pollution, one of the results of burning matter, can cause a slew of health problems, including chronic obstructive pulmonary disease, acute lower respiratory illness, asthma, ischemic heart disease, and lung cancer.
>
> …
>
> Using atmospheric and climate models, the research team found that more than 82 million people are likely to experience an increase in the frequency and duration of smoke waves. Northern California, western Oregon, and the Great Plains are among areas that researchers estimate will be hit hardest by particulate matter (PM2.5) in the atmosphere.
>
> "Wildfires are difficult to predict because they're variable one day to the next and one year to the next," said Jason West, a professor of environmental science at the University of North Carolina. The new research is valuable, he said, because it places the fires into a health context.
>
> "What's interesting [about the study] is that it shows that climate change can have a direct impact on public health," said Mickley. "We're used to thinking of climate change as affecting temperatures and rising sea levels. This is something different that requires a lot of resources to control, affects millions of people, and it has been overlooked."

According to the EPA's *Carbon Monoxide (CO) Pollution in Outdoor Air*, carbon monoxide can cause harmful health effects by reducing oxygen delivery to the body's organs, especially the heart, brain, and tissues. At extremely high levels, CO can cause death. Exposure to CO can reduce the oxygen-carrying capacity of the blood. People with several types of heart disease already have a reduced capacity for pumping oxygenated blood to the heart, which can cause them to experience myocardial ischemia (reduced oxygen to the heart), often accompanied by chest pain (angina), when exercising or under increased stress. For these people, short-term CO exposure further affects their body's already compromised ability to respond to the increased oxygen demands of exercise or exertion.

Ozone reacts with molecules in the lining of our airways. Chemical bonds break and reform in different ways with the addition of oxygen atoms (the process of oxidation) from ozone, and this causes acute inflammation. The lining of our airways loses some of its ability to serve as a protective barrier to microbes, toxic chemicals, and allergens. Our airways respond by covering the affected areas with fluid and by contracting muscles. Breathing becomes more difficult.

Shortness of breath, dry cough or pain when taking a deep breath, tightness of the chest, wheezing, and nausea are common responses to ozone, according to NASA's *The Ozone we Breathe*. Ozone also triggers asthma and may aggravate other respiratory illnesses such as pneumonia and bronchitis. Ozone concentrations can make the small bands of muscles that help control breathing more sensitive to dry air, cold or dust, so ozone exposure may increase allergic responses in susceptible people.

While the effects of acute, short-term episodes of ozone exposure are reversible, the human body's response to long-term exposure may not be reversible. Exposure to ozone at levels we commonly encounter in our own communities permanently scars the lungs of experimental animals, causing long-term impairment of lung capacity, or the volume of air that can be expelled from fully inflated lungs. Ozone may have similar effects on human lungs. Studies in animals suggest ozone may reduce the human immune system's ability to fight bacterial infections in the respiratory system.

Ozone damage to people can occur without any noticeable signs. Even when initial symptoms appear, they can disappear while ozone continues to cause harm. Otherwise, healthy people can expect to experience acute but reversible effects if they exercise regularly outdoors when ozone levels are high. The National Institute of Environmental Health Sciences (NIEHS) considers such people to be especially susceptible as a group (NASA Earth Observatory, 2022).

Particulate matter is also known as particular pollution; it is a complex mixture of extremely small particles and liquid droplets that get into the air. Once inhaled, these particles can affect the heart and lungs, and cause serious health effects, according to EPA. The size of particles is directly linked to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into lungs and the bloodstream. Exposure to such particles can affect both the lungs and heart. As noted by the EPA, People with heart or lung diseases, children, and older adults are the most likely to be affected by particle pollution exposure.

Numerous scientific studies, according to the EPA's *Particulate Matter (PM) Pollution*, have linked particle pollution exposure to problems, including:

- premature death in people with heart or lung disease,
- nonfatal heart attacks,
- irregular heartbeat,
- aggravated asthma,
- decreased lung function, and
- increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

EPA also notes that fine particles (PM2.5) are the main cause of reduced visibility (haze) in parts of the United States, including many of our treasured national parks and wilderness areas. Particles can be carried over long distances by wind and then settle on ground or water. Depending on their chemical composition, the effects of this settling may include:

- making lakes and streams acidic,
- changing the nutrient balance in coastal waters and large river basins,
- depleting the nutrients in soil,
- damaging sensitive forests and farm crops,
- affecting the diversity of ecosystems, and
- contributing to acid rain effects.

Particulate Matter can stain and damage stone and other materials, including culturally important objects such as statues and monuments. Some of these effects are related to acid rain effects on materials, according to the EPA.

Salem Climate Action Plan 2021

The *Salem Climate Action Plan 2021* outlines the following potential vulnerabilities and consequences of various projected climate changes as it relates to air quality.

Projected Wildfire Risk

Increased temperatures and drier conditions will lead to increased fire risk in forested areas outside of Salem. However, those impacts to Salem include health risks due to poor air quality, increased emergency operations and evacuations, and reductions in revenue and employment in the tourism industry.

- Poor to hazardous air quality resulting from wildfires would greatly impact vulnerable populations—for example, people who are unsheltered, people who work outdoors, and people who live with chronic medical conditions such as asthma.

The Salem NHMP Steering Committee rated the city as having **a "high" vulnerability to air quality hazards**, meaning over 10% of the city's population or property would be affected by a major air quality emergency or disaster.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

Drought

Significant Changes Since Previous Plan:

The Drought hazard section has been updated to include new history and additional information since the last plan.

Causes and Characteristics

Drought is a normal, recurrent feature of the climate. It occurs almost everywhere, although it features vary from region to region. According to the National Drought Mitigation Center (University of Nebraska), defining drought is, therefore, difficult; it depends on differences in regions, needs, and disciplinary perspectives. In the most general sense, drought is defined as a deficiency of precipitation over an extended period (usually a season or more), resulting in a water shortage. 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 or county.

In the early 1980s, researchers with the National Drought Mitigation Center and the National Center for Atmospheric Research (NCAR) located more than 150 published definitions of drought. To simplify analysis, the NDMC now provides four primary ways in which drought can be defined based on the impacts of the drought. They are as follows: meteorological, agricultural, hydrological, and socioeconomic. The first three approaches deal with ways to measure drought as a physical phenomenon. The last deals with drought in terms of supply and demand, tracking the effects of water shortfall as it ripples through socioeconomic systems. Figure 9 below illustrates the interrelationship of these types of droughts.

Types of Drought

Meteorological Droughts

Meteorological droughts are defined in terms of the departure from a normal precipitation pattern and the duration of the event. These are region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region. This drought type may relate specific precipitation departures to average amounts on a monthly, seasonal, or yearly basis.

Agricultural Droughts

Agricultural drought links various characteristics of meteorological or hydrological drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, and reduced groundwater or reservoir levels. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil. A good definition of agricultural drought accounts for the variable susceptibility of crops during different stages of crop development, from emergence to maturity.

Hydrological Droughts

Hydrological droughts refer to deficiencies in surface water and sub-surface water supplies. It is measured as stream flow, and as lake, reservoir, and ground water levels. Hydrological measurements are not the earliest indicators of drought. When precipitation is reduced or deficient over an extended period, the shortage will be reflected in declining surface and sub-surface water levels.

Hydrological droughts are usually out of phase with the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, streamflow, and groundwater and reservoir levels. As a result, these impacts are out of phase with impacts in other economic sectors. Also, water in hydrologic storage systems (e.g., reservoirs, rivers) is often used for multiple and competing purposes (e.g., flood control, irrigation, recreation, navigation, hydropower, and wildlife habitat), further complicating the sequence and quantification of impacts. Competition for water in these storage systems escalates during drought and conflicts between water users increase significantly.

Socioeconomic Drought

Socioeconomic definitions of drought associate the supply and demand of some economic good with elements of meteorological, hydrological, and agricultural drought. It differs from the other three types of droughts because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods, such as water, forage, food grains, fish, and hydroelectric power, depends on weather. Because of the natural variability of climate, water supply is ample in some years but unable to meet human and environmental needs in other years. Socioeconomic drought occurs when the demand for an economic good exceeds supply because of a weather-related shortfall in water supply.

In most instances, the demand for economic goods is increasing because of increasing population and per capita consumption. Supply may also increase because of improved production efficiency, technology, or the construction of reservoirs that increase surface water storage capacity. If both supply and demand are increasing, the critical factor is the relative rate of change. Is demand increasing more rapidly than supply? If so, vulnerability and the incidence of drought may increase in the future as supply and demand trends converge.

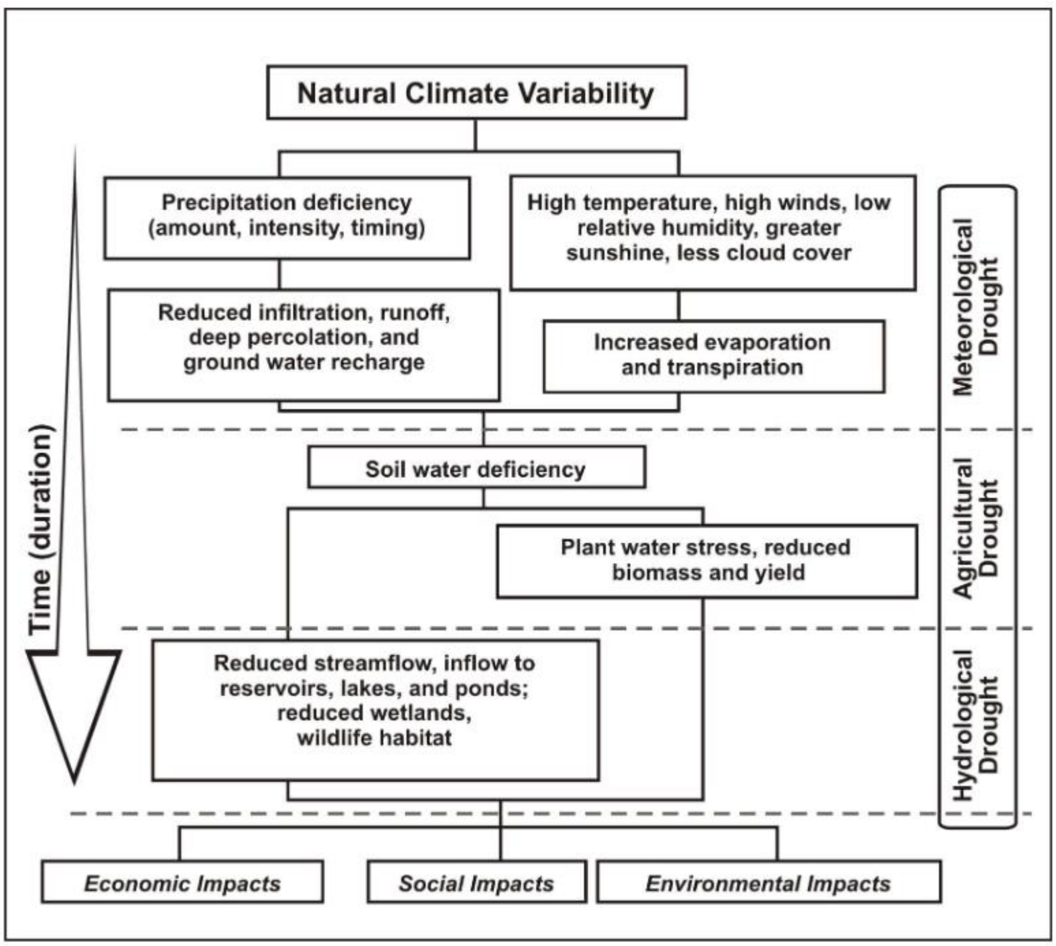
Ecological, Flash, and Snow Drought

In addition to these primary drought designations, three other drought designations—ecological, flash, and snow—were, according to OCCRI's *Fifth Oregon Climate Assessment* (2021), proposed more recently to reflect more-specific drivers and impacts of drought. Ecological drought is defined as "[a]n episodic deficit in water availability that drives ecosystems beyond thresholds of vulnerability, impacts ecosystem services, and triggers feedbacks in natural and/or human systems." Like agricultural drought, ecological drought usually is caused by meteorological and hydrological drought. Vegetation and soil types affect likelihood of ecological drought.

Flash drought refers to relatively short periods of warm surface temperatures, low relative humidity and precipitation deficits, and rapidly declining soil moisture. According to the *Fifth Oregon Climate Assessment* (2021), these droughts tend to develop and intensify rapidly within a few weeks and may be generated or magnified by prolonged heat waves.

Snow droughts are defined when snowpack—or snow water equivalent (SWE)—is below average for a given point in the water year, traditionally April 1. Years with low SWE on April 1 often are followed by summers with low river and stream flows. The low flows sometimes lead to or exacerbate water supply deficiencies, especially in snowmelt-dominated basins. Although the idea of snow drought has existed for many years, it was further developed in Oregon and the Northwest following the 2015 water year, in which below-average snowpack counterintuitively corresponded with above-average precipitation. The *Fifth Oregon Climate Assessment* (2021) indicates that this type of snow drought is classified as warm snow drought. Dry snow drought is classified based on below-average snowpack and precipitation.

Figure 9 Types of Droughts and Impacts



Source: National Drought Mitigation Center.

Location and Extent

Droughts occur in every climate zone and can vary from region to region. Drought may occur throughout Salem and may have profound effects on the economy. 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. The *2020 Oregon Natural Hazards Mitigation Plan*, Mid/ Southern Willamette Valley (Region 3) Risk Assessment states,

> Even though drought may not be declared as often in Western Oregon as in counties east of the Cascades, when drought conditions do develop in the Willamette Valley, the impacts are widespread and severe. Reasons for broad and significant impact include insufficient water for crop irrigation; lack of farmworkers when the growing season begins early; and increased frequency of toxic algal blooms in the Willamette system reservoirs, among other reasons.

The U.S. Drought Monitor (USDM) is the current primary tool used to identify and categorize drought conditions in Oregon (https://droughtmonitor.unl.edu/) and is discussed in the subsequent section. In addition, the Natural Resources Conservation Service (NRCS) SWSI index is of current water conditions throughout the state and further discussed below.

Since the last NHMP update, City of Salem participated in the development of the *North Santiam Watershed Drought Contingency Plan* (NSDCP). The NSDCP was developed by the North Santiam Watershed Task Force to foster a collaborative and non-regulatory approach to drought planning, monitoring, and response within the watershed. The goal of the NSDCP is to build long-term resiliency to drought to minimize impacts to the communities, local economies, and the critical natural resources within the watershed. The NSDCP addresses the entire North Santiam watershed, in addition to, users outside the basin, such as City of Salem. Additional information related to NSDCP planning efforts is discussed later in this section.

Identifying Drought

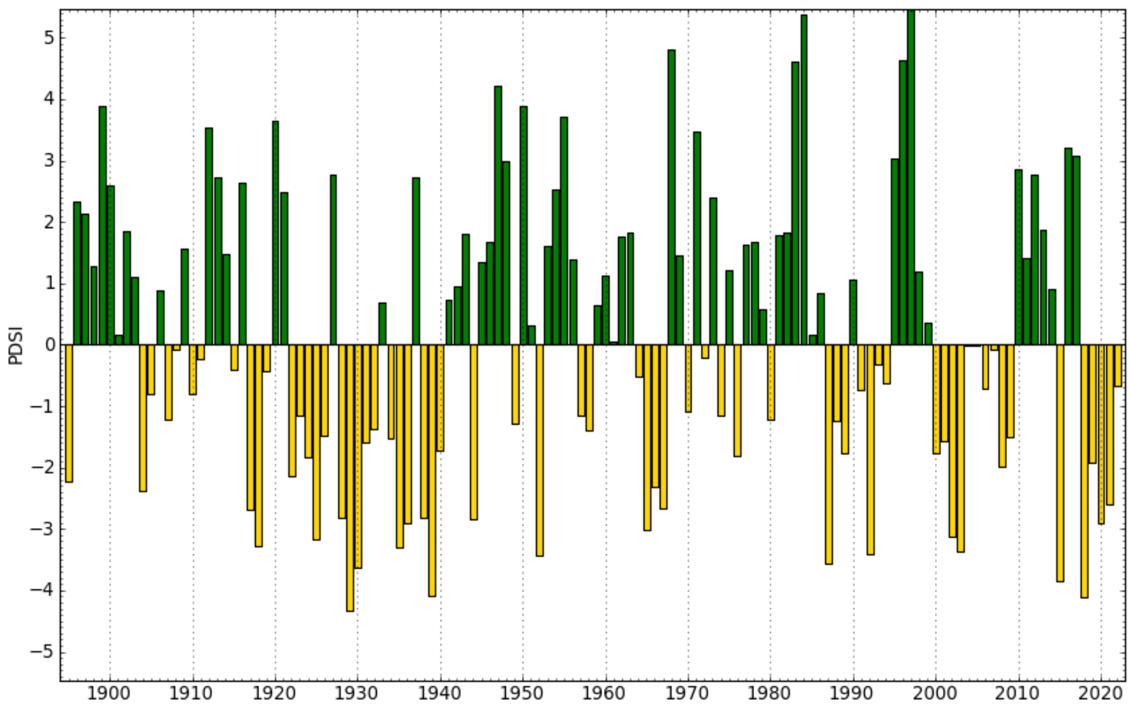
The USDM is the current primary tool used to identify and categorize drought conditions in Oregon. The USDM is not a statistical model, although numeric inputs include the following: Palmer Drought Severity Index, Standardized Precipitation Index, and other climatological inputs; the Keech-Byram Drought Index for fire, satellite-based assessments of vegetation health, and various indicators of soil moisture; and hydrologic data, particularly in the West, such as the Surface Water Supply Index and snowpack. Three of these inputs are discussed below.

An example of a tool used to estimate drought conditions is the *State Water Supply Outlook Report* (WSOR) produced by the NRCS. The State Water Supply Outlook is a report containing forecasts of runoff and snowmelt runoff. It also contains a summary of current snowpack, precipitation, river flow volumes, reservoir storage and soil moisture, and data for these is published in the Maps and Data Summaries section. Runoff from the mountains is important for the major rivers in the province where reservoirs store water supplies for irrigation, hydroelectricity, community, and municipal purposes. Current WSOR are available for Oregon.

Palmer Drought Severity Index

According to NCAR, quantifying drought requires an objective criterion for defining the beginning and end of a drought period. Most federal agencies use the Palmer Drought Severity Index (PDSI). The index incorporates precipitation, runoff, evaporation, and soil moisture as variables. However, the PDSI does not incorporate snowpack as a variable. Therefore, it is does not provide a very accurate indication of drought conditions in Oregon and the Pacific Northwest, although it can be very useful because of its a long-term historical record of wet and dry conditions. The PDSI uses a zero (0) as normal, and drought is shown in terms of negative numbers; for example, negative two (-2.00) is moderate drought, negative three (-3.00) is severe drought, and negative four (-4.00) is extreme drought. Figure 10 illustrates the PDSI for Marion County between 1895 – 2022.

Figure 10 Palmer Drought Severity Index, Marion County, Oregon 1895-2002

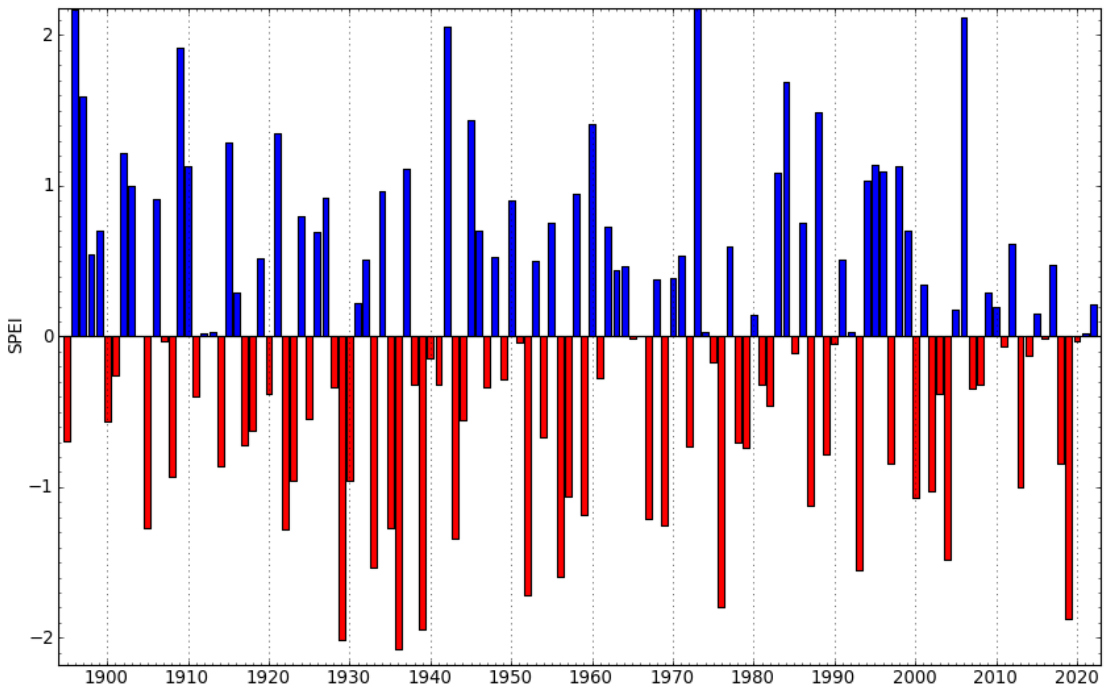


Source: Western Regional Climate Center

Standardized Precipitation Evapotranspiration Index

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. According to *Fifth Oregon Climate Assessment* (2021), it is a key quantitative metric for assessing the occurrence and severity of meteorological and hydrological drought by comparing the net water balance between precipitation and potential evapotranspiration between a recent period and a historical period. The SPEI also 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 *Fifth Oregon Climate Assessment*, (2021) indicates a 12-month SPEI is a reliable predictor of annual streamflow in the Northwest and water levels in lakes and reservoirs. 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 11 Standardized Precipitation-Evapotranspiration Index (SPEI), Marion County, OR 1895-2020

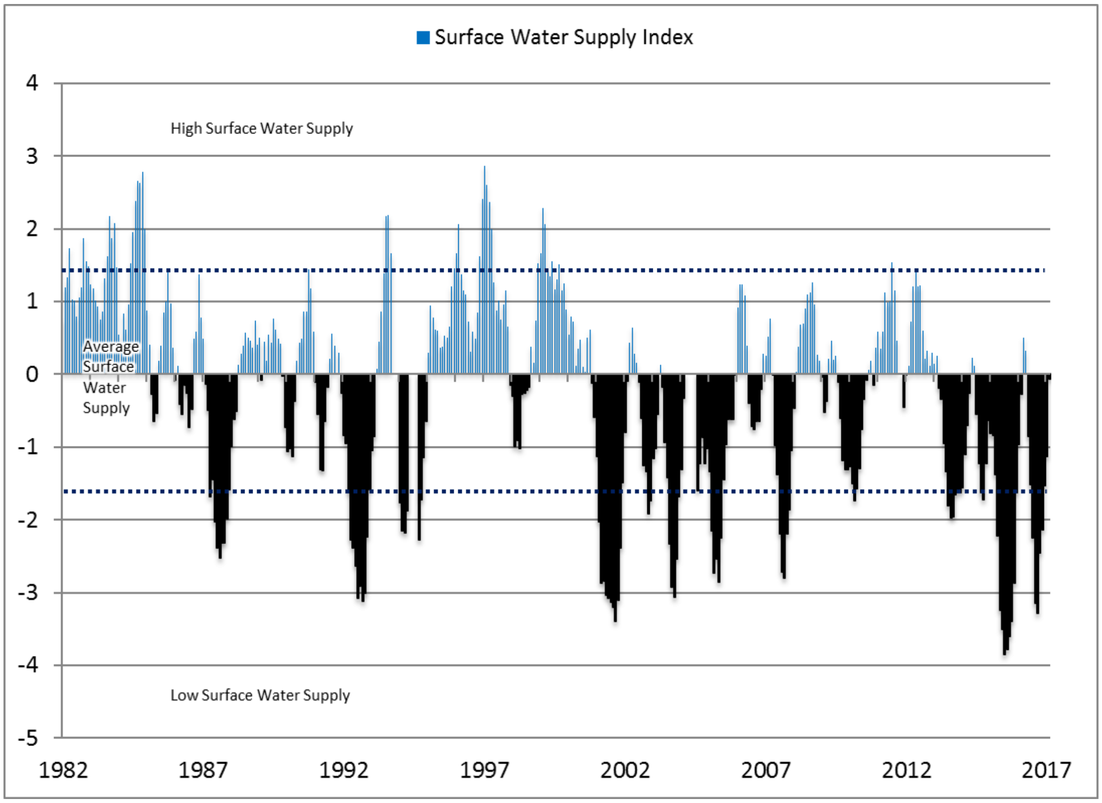


Source: Western Regional Climate Center

Surface Water Supply Index

The SWSI index is of current water conditions throughout the state. The index utilizes parameters derived from snow, precipitation, reservoir and stream flow data. The data is gathered each month from key stations in each basin. The lowest SWSI value, -4.2, indicates extreme drought conditions (Low Surface Water Supply ranges from -1.6 to -4.2). The highest SWSI value, +4.2, indicates extreme wet conditions (High Surface Water Supply ranges from +1.6 to +4.2). The mid-point is 0.0, which indicates an average water supply (Average Water Supply ranges from +1.5 to -1.5). Moderate droughts are classified at SWSI values between -2.0 and -4.0, while severe drought is classified at SWSI values of -4.0 and below. below shows the monthly history of SWSI values from February 1982 to March 2017 for the Willamette Basin which includes Salem.

Figure 12 SWSI Values for the Willamette Basin (1982-2017)



Source: U.S. Natural Resources Conservation Service

Research shows that the periods of drought have fluctuated; recent moderate drought periods occurred in 1987, 1992, 1994, 2001, 2003, 2005, 2015, and 2016. According to the OWRD Public Declaration Status Report, the governor signed a drought declaration for Marion County covering the period from September 18 – December 31, 2015; a period which came close to reaching the severe drought SWSI classification. In addition, there were no drought declarations between 2017 and 2022 for Marion and Polk Counties.

History

Although Salem is spared from most droughts because of its location east of the ocean and west of the Cascades, it has been affected by droughts in the past. The broader region surrounding Salem experiences dry conditions annually during the summer months from June to September. The Drought Monitor (National Weather Service Climate Prediction Center) shows episodes of drought within the past five years occurring during the summer through the fall. Periodically, this region experiences more significant drought conditions that affect the region or the state. Table 4 identifies historic drought events that impacted Salem.

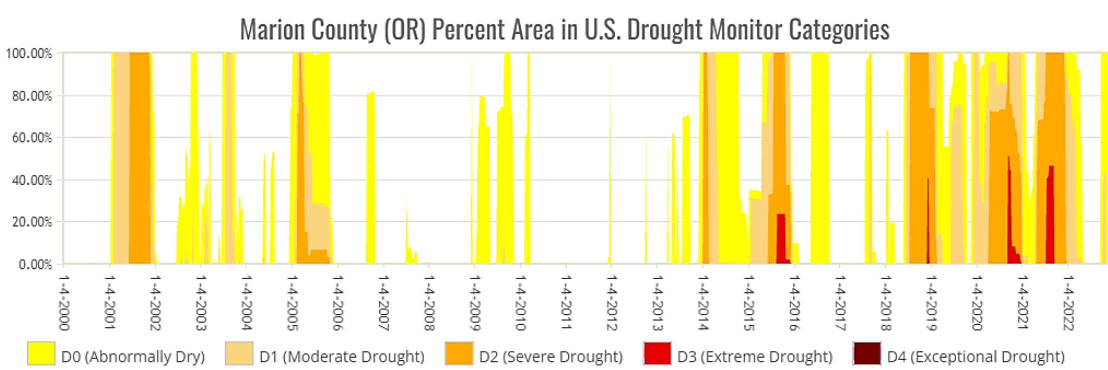
Table 4 Historic Drought Events

Time Period	Drought Description
1928-1941	Statewide drought
1976-1981	Low stream flows prevailed in western Oregon
1976-1977	Driest year of the century
1985-1994	Drought was not as severe as the 1976-77 drought in any single year, but the cumulative effect of ten consecutive years with mostly dry conditions caused statewide problems.
1992	The peak year of the drought when a drought emergency was declared for all of Oregon.
2015-2016	Two drought events
2017-2022	No drought declarations

Source: Taylor, 1999

For additional historical drought events for the Mid/ Southern Willamette Valley refer to the *2020 Oregon Natural Hazards Mitigation Plan*, Mid/ Southern Willamette Valley (Region 3) Risk Assessment.

Figure Cr Marion County Percent Area in U.S. Drought Monitor Categories (2000-2022)



Source: National Drought Mitigation Center.

El Niño

El Niño Southern Oscillation (ENSO) weather patterns can increase the frequency and severity of drought. During El Niño periods, alterations in atmospheric pressure in equatorial regions yield an increase in the surface temperature off the west coast of North America. This gradual warming sets off a chain reaction affecting major air and water currents throughout the Pacific Ocean. In the North Pacific, the Jet Stream is pushed north, carrying moisture laden air up and away from its normal landfall along the Pacific Northwest coast. In Oregon, this shift results in reduced precipitation and warmer temperatures, normally experienced several months after the initial onset of the El Niño. 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. 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. The last major El Niño was during 1997-1998. After that event, four El Niño events occurred but each were weaker and had shorter effects than the 1997–98 event.

Future Climate Variability

Even though drought is infrequent in the Willamette Valley where Salem is located, climate models project warmer, drier summers for Oregon according to the OCCRI *Fifth Oregon Climate Assessment* (2021). The *2020 Oregon Natural Hazards Mitigation Plan* indicates that for the Mid/Southern Willamette Valley (Region 3), these summer conditions coupled with projected decreases in mid-to-low elevation mountain snowpack due to warmer winter temperatures increases the likelihood that Salem would experience increased frequency of one or more types of drought under future climate change. In the Salem area, climate change would result in increased frequency of drought due to low spring snowpack, low summer runoff, and low summer precipitation and low summer soil moisture. In addition, the Mid/Southern Willamette Valley, like the rest of Oregon is projected to experience an increase in the frequency of summer drought conditions as summarized by the SPEI due largely to projected decreases in summer precipitation and increases in potential evapotranspiration.

The *Salem Climate Action Plan 2021*, includes numerous strategies to address a variety of climate-related challenges facing the city including drought. The plan acknowledges significant projected climate impacts including the following:

- The number of days with a heat index over 90°F will increase from a historic average of 7 per year to 33 per year by mid-century.
- Hotter and drier conditions are likely to cause more frequent droughts.
- Wildfire is a significantly increasing risk across the state of Oregon. The number of extreme fire danger days in Salem will double by mid-century, increasing from a historic average of 10 per year to 20 per year. Extremely large, intense fires will become more likely under hotter and drier climate scenarios.

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. The 2020 Oregon NHMP states the following regarding the probability for the drought hazard in Mid/ Southern Willamette Valley (Region 3),

> Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases.

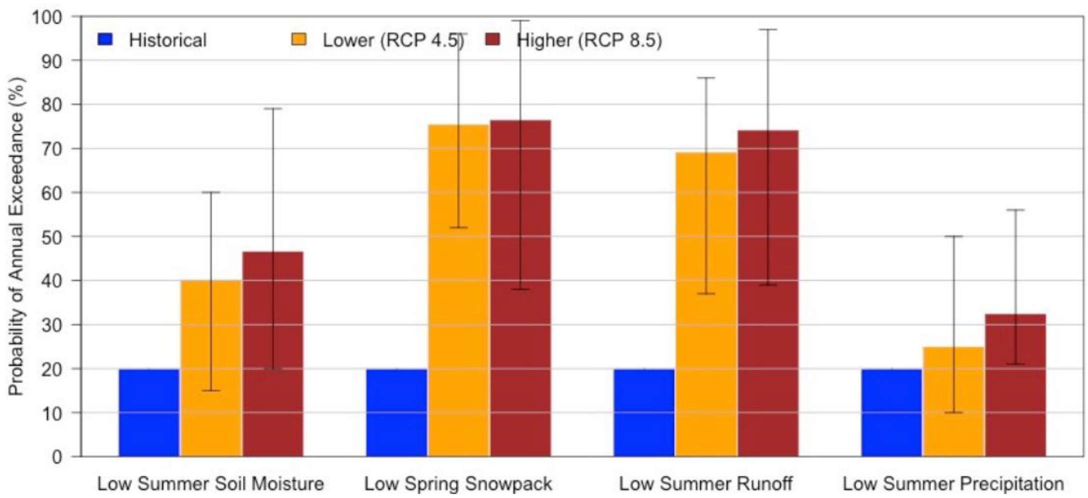
A comprehensive risk analysis is needed to fully assess the probability and impact of drought to Oregon communities. Such an analysis could be completed statewide to analyze and compare the risk of drought across the state.

Benton, Polk, and Yamhill Counties have received drought declarations in only 3% of the years since 1992, Marion and Linn in 7%, and Lane in 10%. This accounts for their very low and low probability, respectively, of experiencing drought.

Based on the available data and research for Salem the NHMP Steering Committee assessed the **probability of experiencing a locally severe drought as "high,"** meaning one incident is likely within a 10 to 35-year period.

Figure 14 shows the projected probability of exceeding the magnitude of seasonal drought conditions for which the historical annual probability of exceedance was 20%.

Figure 14 Projected Future Drought in Marion County



Source: Dalton et al., 2022
Note: 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.

Vulnerability Assessment

Droughts in the past have caused no personal injury or death. The potential for future injuries or deaths is anticipated to increase compared to historic events. Salem estimates that greater than 10% of the city's population or property is likely to be affected by drought conditions. The following summary is reflected in the 2020 Oregon NHMP, regarding the Mid/ Southern Willamette Valley (Region 3) vulnerability of drought to the region,

Although long-term drought conditions are uncommon in the mid-Willamette Valley, a dry winter or spring could affect many communities and water users throughout the Basin. Recreation, particularly at the reservoirs owned and operated by the U.S. Army Corps of Engineers, contributes greatly to the valley's economy. Communities, such as Detroit in Marion County, can be economically impacted by

> low reservoir levels. The Willamette Valley is also home to one of the most productive and diverse agricultural regions in the United States. Drought, especially a long drought, could significantly impact agricultural production.
>
> Impacts of drought on state-owned facilities related to agriculture would include impacts to research conducted in outdoor settings, such as at extension stations and research farms.
>
> Because drought impacts are relatively recent in Region 3, there is no single comprehensive source or other sources for information to assess economic impacts.
>
> Oregon has yet to undertake a comprehensive, statewide analysis to identify which communities are most vulnerable to drought.

The 2020 Oregon NHMP continues by addressing social vulnerability,

> The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.
>
> According to the CDC Social Vulnerability Index, social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties. Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than "well." …
>
> Marion County's social vulnerability score is very high, Linn and Yamhill Counties' high. Lane and Polk Counties' social vulnerability score is moderate, Benton County's low. The social vulnerability score indicates the extent of impact of any natural hazard, including drought, on a county's population. Marion, Linn, and Yamhill are the communities most vulnerable to drought in Region 3.

Facilities throughout the city anticipate little or no damage due to a drought, estimated at less than $1 million for hazard response, structural repairs and equipment replacement. In terms of commercial business, it is likely less than 10% of businesses located in the city and surrounding area could experience commerce interruption for a period of days. The agricultural sector could suffer the greatest impact from a drought in comparison to other types of business. Lastly, drought would likely have moderate impacts on more than 75% of the city's ecological systems, including, clean water, wildlife habitat, and parks. Also, domestic water-users may be subject to stringent conservation measures (e.g., rationing) as per the city's water conservation plan.

Salem Climate Action Plan

The *Salem Climate Action Plan 2021* outlines the following potential vulnerabilities and consequences of various projected climate changes as it relates to drought and extreme heat events.

Projected Temperature Increases

While higher summer temperatures may lead to health impacts for vulnerable populations, the temperature increase is not projected to be extreme and may be offset by people's ability to naturally acclimate to changing temperatures over time.

- Increased risk of heat-related illnesses to small children, the elderly, people with chronic illnesses, residents living at or near the poverty line, and people who work outside (e.g., farmworkers and construction workers), and people who are unsheltered.
- Increased risk of respiratory problems.
- Salem's population is expected to grow 28% by 2035. Combined with warming temperatures, increases in population mean more people will likely use air conditioning on the warmest days, which may lead to an increased demand for electricity.
- Warming temperatures may allow for new pests to infiltrate the area. New pests may have the ability to negatively impact Salem's ecosystems, for example by harming the Salem's tree canopy and spreading disease.
- Decreased water levels in the reservoirs on the North Santiam River which provide all of Salem's water.

Projected Precipitation Patterns

Though overall precipitation amounts are expected to remain consistent, increased temperatures noted above will lead to a water deficit.

- Increased risk of drought, especially when combined with warmer temperatures.
- Water use restrictions and food insecurity in periods of drought.

North Santiam Watershed Drought Contingency Plan

The goal of *North Santiam Watershed Drought Contingency Plan*, as noted previously, is to build long-term resiliency to drought to minimize impacts to the communities, local economies, and the critical natural resources within the watershed. The NSDCP assessed vulnerabilities through inventory of watershed assets and other resources at risk in the event of water shortage. The plan reviews the extent to which the assets are vulnerable now and into the future, and the underlying causes of the vulnerability was examined.

The following list includes the NSDCP prioritized grouped assets at risk because of drought. Those assets in bold are the most vulnerable assets under current conditions.

- **Municipal water users: Detroit, Idanha, Lyons-Mehama, Gates, Stayton, and Salem**
- **In-stream natural resources (e.g., endangered species, water quality, and wetlands)**
- **Commercial crop irrigation**

- **Municipal-supplied commercial/industrial use**
- Fire suppression
- Individual domestic water
- **Water oriented recreation**
- Non-commercial irrigation
- Hydropower
- Upland natural resources
- Other irrigation/watering

The NHMP Steering Committee rated the city as having **a "high" vulnerability to drought hazards**, meaning greater than 10% of the city's population or property would be affected by a major drought emergency or disaster.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

Earthquake

Significant Changes Since Previous Plan:

The Earthquake Hazard section was reformatted and expanded with additional information since the previous plan.

Causes and Characteristics

Earthquakes occur in Oregon every day; every few years an earthquake is large enough for people to feel; and every few decades there is an earthquake that causes damage. Each year, the Pacific Northwest Seismic Network locates more than 1,000 earthquakes greater than magnitude 1.0 in Washington and Oregon. Of these, approximately two dozen are large enough to feel. These noticeable events offer a subtle reminder that the Pacific Northwest is an earthquake-prone region.

Seismic hazards pose a real and serious threat to many communities in Oregon, including Salem, requiring local governments, planners, and engineers to consider their community's safety. Currently, no reliable scientific means exists to predict earthquakes. Identifying seismic-prone locations, adopting strong policies and implementing measures, and using other mitigation techniques are essential to reducing risk from seismic hazards in the Willamette Valley, which includes Salem.

Types of Earthquakes

Oregon and the Pacific Northwest in general are susceptible to earthquakes from four sources: 1) shallow crustal fault – slippage events within the North American Plate; 2) deep intra-plate events within the subducting Juan de Fuca Plate; 3) the off-shore Cascadia Subduction Zone (CSZ); and 4) earthquakes associated with renewed volcanic activity. The first three identified are discussed below under Identifying Earthquakes. Marion County, which Salem is included, is primarily susceptible to crustal and subduction zone earthquakes.

While all three types of earthquakes have the potential to cause major damage, subduction zone earthquakes pose the greatest danger. A major CSZ event could generate an earthquake with a magnitude 9.0 or greater resulting in devastating damage and loss of life. Such earthquakes may cause great damage to the coastal area of Oregon as well as inland areas in western Oregon. It is estimated that shaking from a large subduction zone earthquake could last up to five minutes.

Characteristics of Earthquakes

The following are earthquake-induced hazards:

Ground Shaking

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. Ground shaking is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault that is slipping, and distance from the epicenter (where the earthquake originates).

Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock. The amount of damage sustained by a building during a strong earthquake is difficult to predict and depends on the size, type and location of the earthquake, the characteristics of the soils at the building site, and the characteristics of the building itself, according to DOGAMI's Earthquakes in Oregon site.

Figure 15 shows the expected shaking/damage potential for Salem resulting from a Cascadia Subduction Zone event. The figure shows that the city will experience "very strong" to "severe shaking" that will last two to four minutes. The strong shaking will be extremely damaging to lifeline transportation routes including Interstate 5.

The figure shows that the city will experience "very strong" to "severe shaking" that will last two to four minutes. The strong shaking will be extremely damaging to lifeline transportation routes including Interstate-5. For more information on expected losses due to a CSZ event see *The Oregon Resilience Plan* (2013).

DOGAMI's *Multi-Hazard Risk Report for Marion County, Oregon* (Williams et al., 2022) includes Figure 16, below, which shows anticipated shaking due to a magnitude 6.6 earthquake on the Mt. Angel fault. The City of Salem Expected Shaking related to Cascadia Subduction Zone is shown in Figure 15.

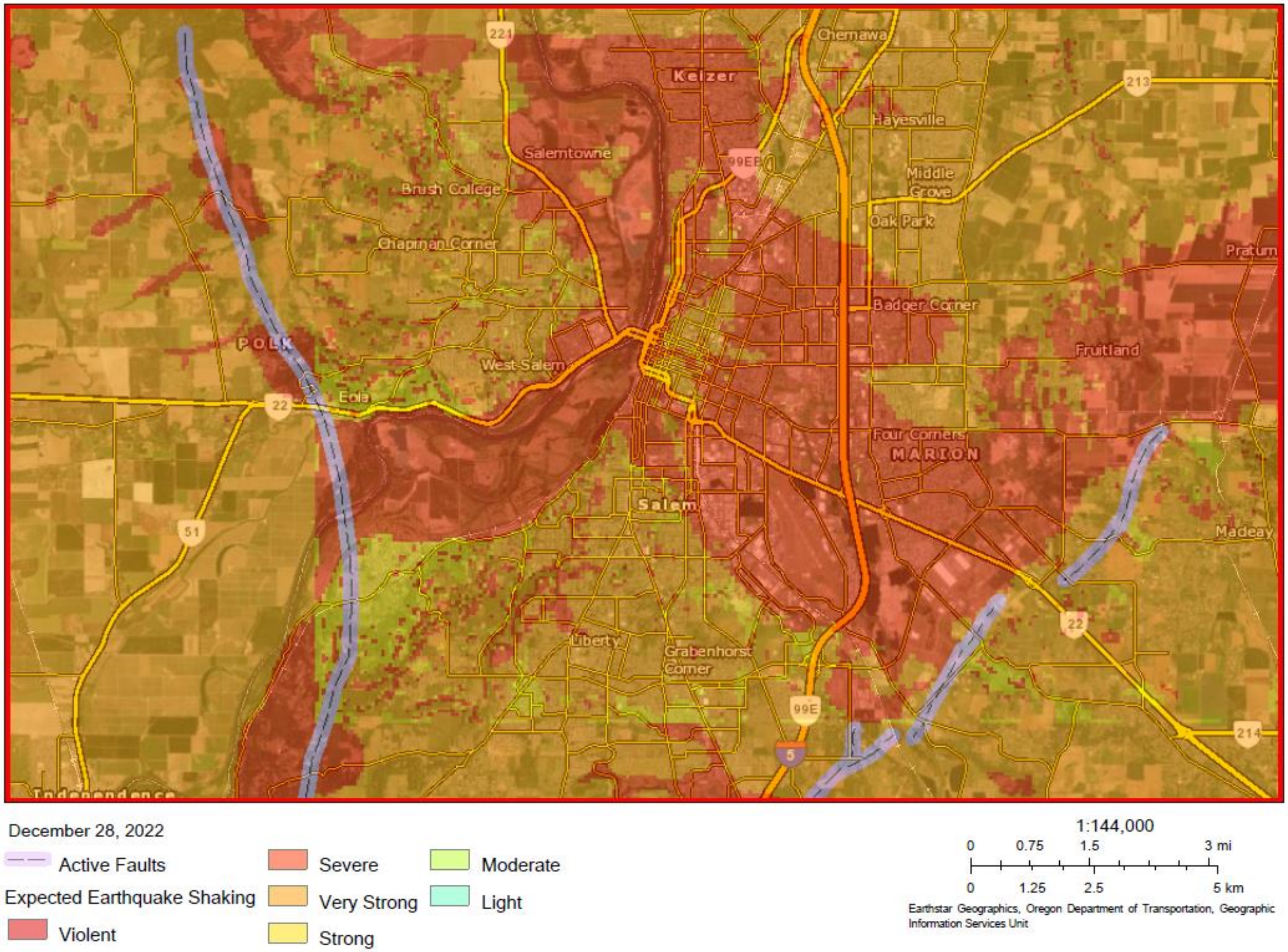
Ground Shaking Amplification

Ground shaking amplification refers to the soils and soft sedimentary rocks near the surface that can modify ground shaking from an earthquake. Such factors can increase or decrease the amplification (i.e., strength) as well as the frequency of the shaking. The thickness of the geologic materials and their physical properties determine how much amplification will occur. Ground motion amplification increases the risk for buildings and structures built on soft and unconsolidated soils.

Surface Faulting

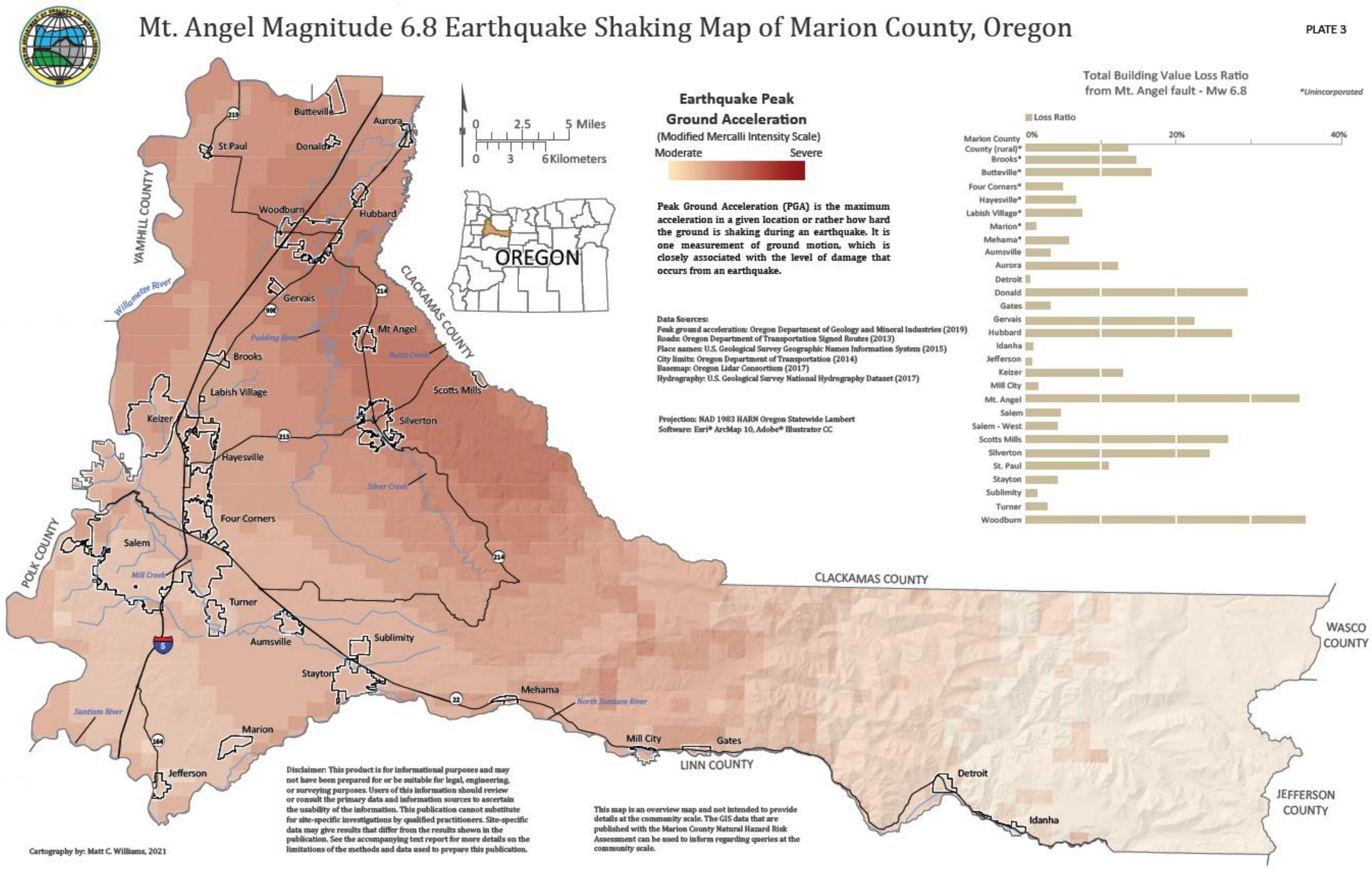
Surface faulting are planes or surfaces in Earth materials along which failure occurs. Such faults can be found deep within the earth or on the surface. Earthquakes occurring from deep lying faults usually create only ground shaking.

Figure 15 Cascadia Subduction Zone Expected Shaking Map of City of Salem



Source: Williams et al., 2022

Figure 16 Mt. Angel Magnitude 6.8 Earthquake Shaking Map of Marion County, Oregon



Source: Williams et al., 2022

Liquefaction and Subsidence

Liquefaction occurs when ground shaking causes wet, granular soils to change from a solid state into a liquid state. This results in the loss of soil strength and the soil's ability to support weight. When the ground can no longer support buildings and structures (subsidence), buildings and their occupants are at risk.

Earthquake-Induced Landslides and Rockfalls

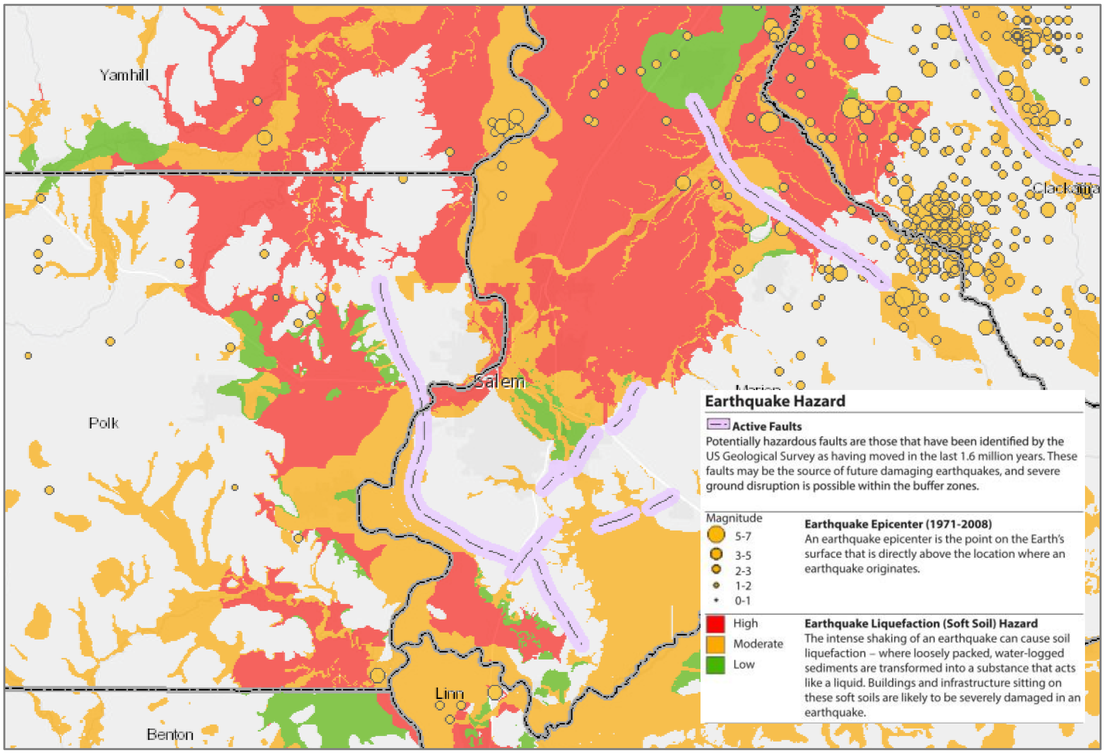
Earthquake-induced landslides are secondary hazards that occur from ground shaking and can destroy roads, buildings, utilities and critical facilities necessary to recovery efforts after an earthquake. These areas often have a higher risk of landslides and rockfalls triggered by earthquakes.

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.

Location and Extent

Figure 17 shows a generalized geologic map of Salem and includes the Mount Angel, Canby-Mollala, and Newberg faults. Within the Salem Urban Growth Boundary (UGB), the area south of the Willamette River and west of River Road has the highest risk of earthquakes. Other small areas with high earthquake risk exist to the east of the city. According to DOGAMI's *Geologic Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage Estimates for Six Counties in the Mid/Southern Willamette Valley* (Burns et al., 2008)*,* the areas that are most susceptible to ground amplification and liquefaction have young, soft alluvial sediments, found in most of the Willamette Valley and are along stream channels. The extent of the damage to structures and injury and death to people will depend upon the type of earthquake, proximity to the epicenter and the magnitude and duration of the event.

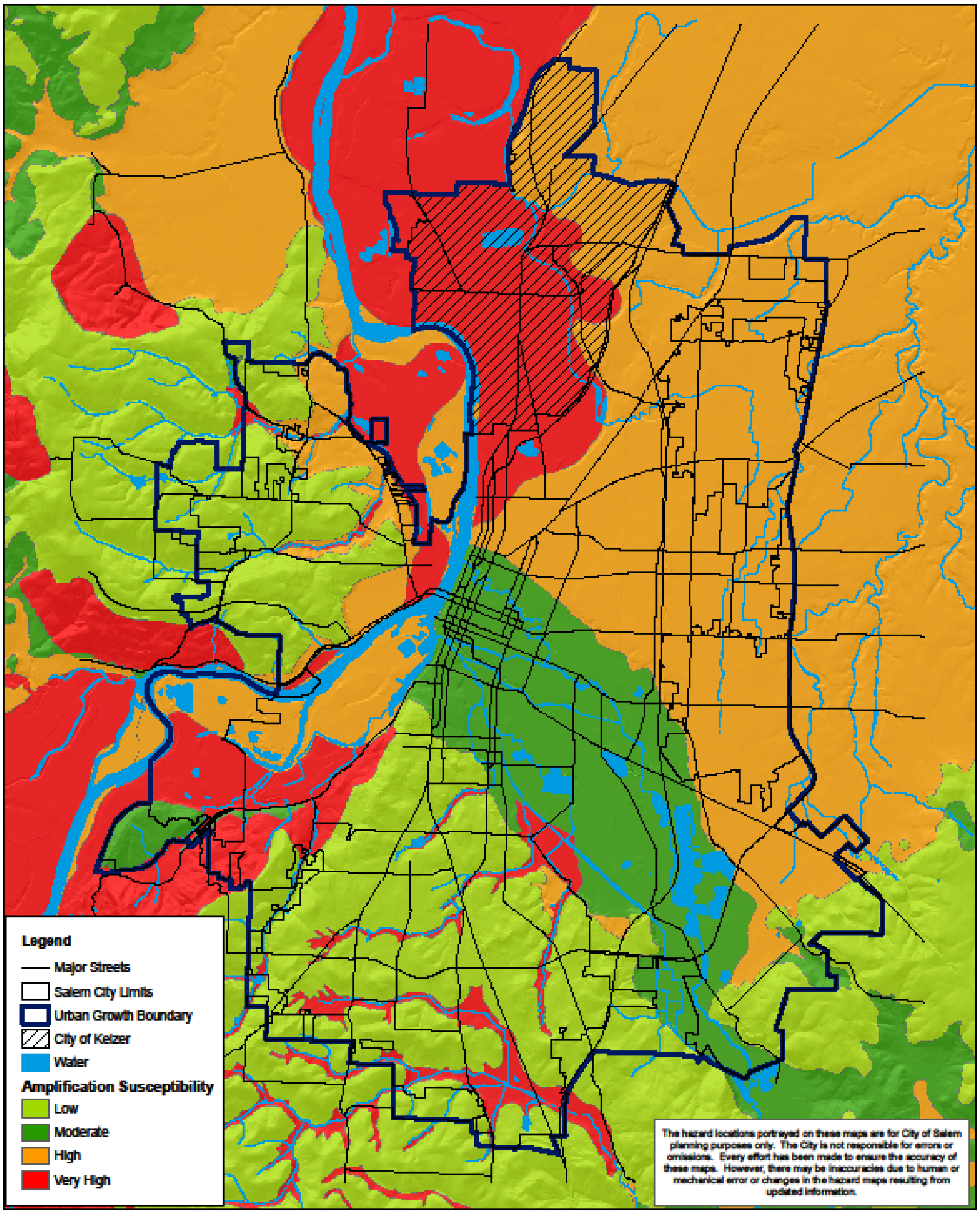
Figure 17 Earthquake Epicenters (1971-2008), Active Faults, and Soft Soils



Source: Oregon Department of Geology and Mineral Industries, Oregon HazVu

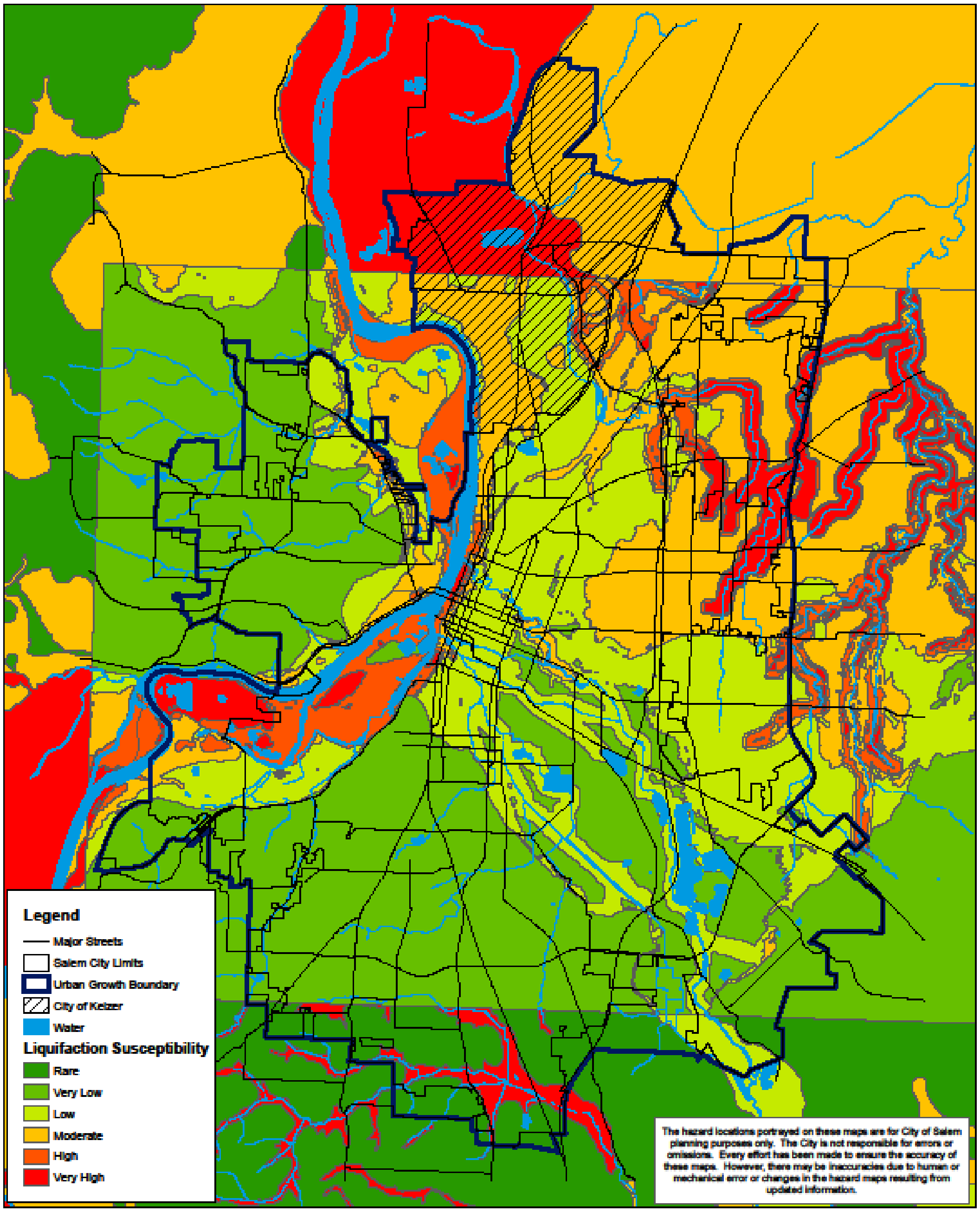
DOGAMI, in partnership with other state and federal agencies, has undertaken a rigorous program in Oregon to identify seismic hazards, including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides. Several seismic hazard maps have been published and are available for communities to use. The maps show ground motion amplification (Figure 18), liquefaction (Figure 19), landslide susceptibility, and relative earthquake hazards. The DOGAMI Statewide Geohazards Viewer was used to present a visual map of recent earthquake activity, active faults, and liquefaction; ground shaking is generally expected to be higher in the areas marked by soft soils in the map above. The severity of an earthquake is dependent upon several factors including the distance from the earthquake's source (or epicenter), the ability of the soil and rock to conduct the earthquake's seismic energy, the degree (i.e., angle) of slope materials, the composition of slope materials, the magnitude of the earthquake, and the type of earthquake.

Figure 18 Earthquake Amplification Susceptibility



Source: City of Salem; Oregon Department of Geology and Mineral Industries

Figure 19 Earthquake Liquefaction Susceptibility



Source: City of Salem; Oregon Department of Geology and Mineral Industries

For more information, see the following reports:

[Interpretive Map Series: IMS-6](), Water-induced landslide hazards, western portion of the Salem Hills, Marion County, Oregon by Andrew F. Harvey and Gary L. Peterson, 1998, 13 p., 1:24,000

Interpretive Map Series: IMS-8, Relative earthquake hazard maps for selected urban areas in western Oregon: Canby-Barlow-Aurora, Lebanon, Silverton-Mount Angel, Stayton-Sublimity-Aumsville, Sweet Home, Woodburn-Hubbard

Interpretive Map Series: IMS-17, Earthquake-induced slope instability; relative hazard map, western portion of the Salem Hills, Marion County, Oregon by R. Jon Hofmeister, Yumei Wang, and David K. Keefer, 2000, 1:24,000

Interpretive Map Series: IMS-24, Geologic hazards, earthquake and landslide hazard maps, and future earthquake damage estimates for six counties in the Mid/Southern Willamette Valley including Yamhill, Marion, Polk, Benton, Linn, and Lane Counties, and the City of Albany, Oregon

Geologic Map Series: GMS-105, Relative earthquake hazard maps of the Salem East and Salem West quadrangles, Marion and Polk Counties, Oregon by Yumei Wang and William J. Leonard, 1996, 10 p., 1:24,000

Open-File Report: O-2003-02, Map of Selected earthquakes for Oregon (1841-2002), 2003

Open-File Report: O-2007-02, Statewide seismic needs assessment: Implementation of Oregon 2005 Senate Bill 2 relating to public safety, earthquakes, and seismic rehabilitation of public buildings, 2007

Open-File Report: O-2013-22, Cascadia Subduction Zone earthquakes: A magnitude 9.0 earthquake scenario, 2013

Special Papers: SP-29, Earthquake damage in Oregon Preliminary estimates of future earthquake losses (1999)

Additional reports are available via DOGAMI's Publications Center website: https://www.oregongeology.org/pubs/

Oregon Seismic Safety Policy Advisory Commission Reports: *The Oregon Resilience Plan* (2013)

Identifying Earthquakes

Oregon Department of Geology and Mineral Industries, 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.

Most large earthquakes in the Pacific Northwest are shallow crustal, deep intraplate, or subduction zone earthquakes. These earthquakes can have great impact on Oregon communities. The extent of the damage to structures and injury and death to people will depend upon the type of earthquake, proximity to the epicenter and the magnitude and duration of the event.

Crustal Fault Earthquakes

According to OEM's *Cascadia Playbook* (2018). Crustal fault earthquakes are the most common and occur at relatively shallow depths of 6-12 miles below the surface. While most crustal fault earthquakes are smaller than magnitude 4.0 and generally create little or no damage, some can produce earthquakes of magnitude 7.0 and higher and cause extensive damage. Crustal earthquakes within the North American plate are possible on faults mapped as active or potentially active as well as on unmapped (unknown) faults.

Deep Intraplate Earthquakes

Occurring at depths from approximately 30 – 37 miles below the earth's surface in the subducting oceanic crust, deep intraplate earthquakes can reach magnitude 7.5, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. This type of earthquake is more common in the Puget Sound of Washington. In Oregon these earthquakes occur at lower rates, and none have occurred at a damaging magnitude, according to the 2020 Oregon NHMP. The February 28, 2001, earthquake in Washington State was a deep intraplate earthquake. It produced a rolling motion that was felt from Vancouver, British Columbia to Coos Bay, Oregon and east to Salt Lake City, Utah (Hill, 2002). A 1965 magnitude 6.5 intraplate earthquake centered south of the Seattle-Tacoma International Airport caused seven deaths (Hill, 2002).

Subduction Zone Earthquakes

The Pacific Northwest is located at a convergent plate boundary where the Juan de Fuca and North American tectonic plates meet. The two plates are converging at a rate of about 1.5 inches per year. This boundary is called the Cascadia Subduction Zone (CSZ) and is illustrated in Figure 20. The CSZ extends from British Columbia to northern California. Subduction zone earthquakes are caused by the abrupt release of slowly accumulated stress. Subduction zones like the Cascadia Subduction Zone have produced earthquakes with magnitudes 8.0 or greater. Historic subduction zone earthquakes include the 1960 Chile (magnitude 9.5) and the 1964 southern Alaska (magnitude 9.2) earthquakes. Geologic evidence shows that the Cascadia Subduction Zone has generated great earthquakes, most recently about 300 years ago. The largest is generally accepted to have been magnitude 9.0 or greater. According to Oregon State University (2016) research[3], the subduction zone earthquakes off Oregon and Washington more frequent than previously estimated. They state,

> A section of the zone from Newport to Astoria, Oregon, was previously believed to rupture on average about every 400-500 years, and that average has now been reduced to 350 years. A section further north from Astoria to Vancouver Island was previously believed to rupture about every 500-530 years, and that average has now been reduced to 430 years… The southern portions of the subduction zone south of Newport, Oregon, tend to rupture more frequently - an average of about every 300-380 years from Newport to Coos Bay, and 220-240 years from Coos Bay to Eureka, California.

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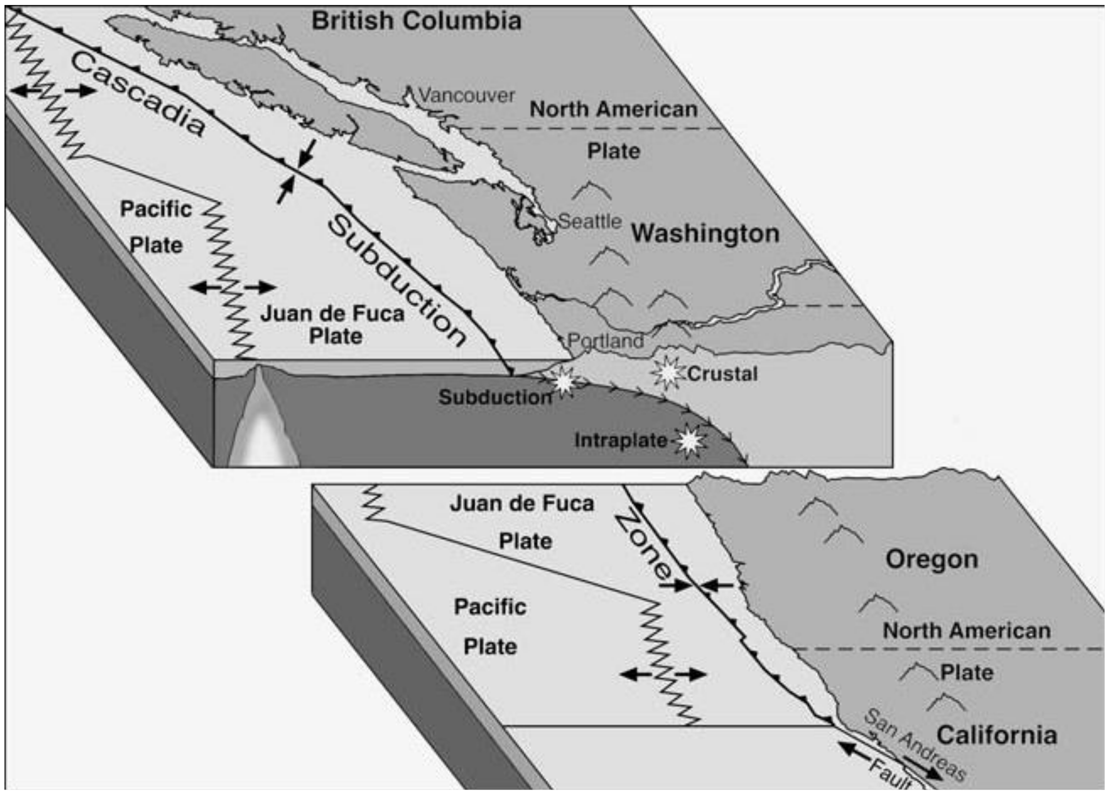
[3] The work was done by researchers from Oregon State University, Camosun College in British Columbia and Instituto Andaluz de Ciencias de la Tierra in Spain. The findings were published in the journal, Marine Geology.

Such earthquakes may cause great damage to the coastal area of Oregon as well as inland areas in western Oregon. It is estimated that shaking from a large subduction zone earthquake could last up to five minutes.

While all three types of earthquakes have the potential to cause major damage, subduction zone earthquakes pose the greatest danger. A major CSZ event could generate an earthquake with a magnitude of 9.0 or greater resulting in devastating damage and loss of life. Such earthquakes may cause great damage to the coastal area of Oregon as well as inland areas in western Oregon.

Figure 20 Cascadia Subduction Zone



Source: Oregon Department of Land Conservation and Development, 1998

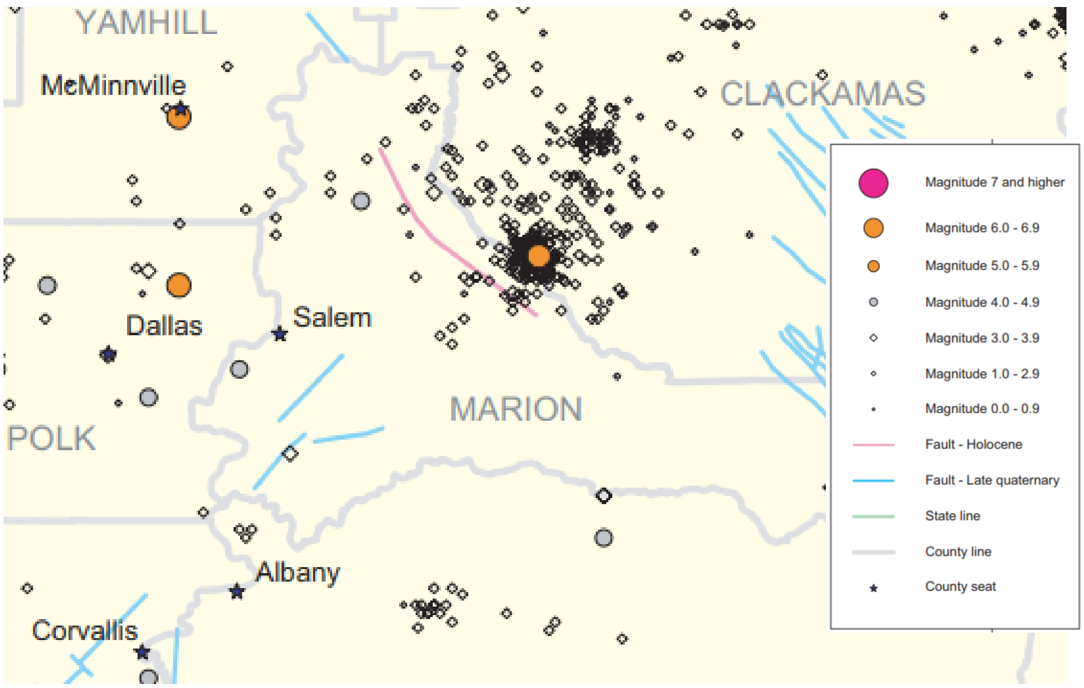
History

The region has been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered off the Oregon coast. There have been multiple moderate earthquakes in Marion County in the past 100 years. Earthquakes with magnitudes of 5.0 and 4.6 occurred in Salem in 1957 and 1963 respectively. Minor damage was reported following both events. In the greater Marion County region, the most significant event in the region occurred near Scotts Mills in March of 1993. This magnitude 5.7 event resulted in damage throughout Marion County including cracking the rotunda of the state Capitol cracked, and the nearly rocking the Golden Pioneer statue off its base (Elliott, 1993). In Mount Angel, authorities closed the historic St. Mary Catholic Church for fear its 200-foot bell tower could collapse. Chunks of plaster fell from the walls at the Queen of Angels

Monastery. Woodburn felt the strongest effects of the quake. Officials shut down four century-old brick and mortar buildings that began to crumble. At a Walmart store, fumes overcame several employees when pesticides, paints and car batteries mixed (Elliott, 1993).

Historically observed crustal earthquakes in Oregon from 1841 to 2002 are shown in DOGAMI Open-File Report O-2003-02. Figure 21 below shows only part of this map, focused on Salem and nearby counties. During this period, several small earthquakes occurred in Marion and Polk County. Larger earthquakes in nearby counties are also shown.

Figure 21 Map of Selected Earthquakes for Oregon, 1841 through 2002



Source: Niewendorp, 2003

Salem has not experienced any major earthquake events in recent history. Seismic events do, however, pose a significant threat. Specifically, a CSZ event could produce catastrophic damage and loss of life in Salem. Table 5 has a list of the significant earthquakes that have affected the Mid/Southern Willamette Valley, which Salem is located.

Table 5 Significant Earthquakes Affecting Mid/Southern Willamette Valley

Date	Location	Magnitude	Comments
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	Offshore, Cascadia Subduction Zone	Probably 8-9	Mid-points of the age ranges for these six events
Jan. 1700	Offshore, Cascadia Subduction Zone	Approximately 9.0	Generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Apr. 1896	McMinnville, Oregon	4	Also felt in Portland
July 1930	Perrydale, Oregon	4	Cracked plaster
Apr. 1949	Olympia, Washington	7.1	Intraplate event. Damage: significant (Washington); minor (NW Oregon)
Aug. 1961	Albany, Oregon	4.5	Damage: minor (Albany)
Nov. 1962	Portland area, Oregon	5.5	Shaking up to 30 seconds. Damage: chimneys cracked; windows broken; furniture moved.
Mar. 1963	Salem, Oregon	4.6	Damage: minor (Salem)
Mar. 1993	Scotts Mills, Oregon	5.6	FEMA-985-DR-Oregon; center: Mt. Angel-Gales Creek fault. Damage: $30 million (including Oregon State Capitol in Salem)
Feb. 2001	Nisqually, Washington	6.8	Felt in the region. Damage: none reported
Jul. 4, 2015	East of Springfield, OR	4.0	

Sources: 2020 Oregon NHMP, Wong and Bolt (1995)
*BCE: Before Common Era.

Future Climate Variability

Future climate variability does not affect the community's earthquake risk.

Probability Assessment

Based on the historical seismicity in western Oregon and on analogies to other geologically similar areas, small to moderate earthquakes up to magnitude 5.0 or 5.5 are possible almost any place in western Oregon, including almost any place in Marion County, including Salem.

Such earthquakes would mostly be much smaller than the 1993 Scotts Mills earthquake, which had a magnitude 5.7. The possibility of larger crustal earthquakes in the magnitude 6.0 or greater cannot be ruled out. However, the probability of such events is likely to be very low. For more information see DOGAMI reports linked above.

Because the probability of large crustal earthquakes (magnitude 6.0 or greater) affecting Salem is low and because any damage in smaller crustal earthquakes is likely to be minor and very localized, crustal earthquakes are not considered significant for hazard mitigation planning purposes. Therefore, our analysis focuses on the larger, much more damaging earthquakes arising from the CSZ.

The 2020 Oregon NHMP Risk Assessment for Region 3 concluded that the probability of damaging earthquakes varies widely across the state. In Region 3, the hazard is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history. DOGAMI has developed a new probability ranking for Oregon counties that is based on the average probability of experiencing damaging shaking during the next 100 years, modified in some cases by the presence of newly discovered lidar faults. In this ranking Marion and Polk County, which Salem resides, is estimated to have a 32-45% chance of experiencing damaging shaking during the next 100 year.

According to research by Oregon State University (2016), the return period for the largest of the CSZ earthquakes (magnitude 9.0 or greater) is 430 years with the last CSZ event occurring 323 years ago in January of 1700. Moreover, the probability of a magnitude 9.0 or greater CSZ event occurring in the next 50 years ranges from –15-20%. Notably, an additional 10 - 20 smaller, magnitude 8.3 - 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 approximately 240 years. The combined probability of any CSZ earthquake occurring in the next 50 years is 37 - 43%. However, according to a U.S. Geological Survey paper, “Failure analysis suggests that by the year 2060, Cascadia will have exceeded ~27% of Holocene recurrence intervals for the northern margin and 85% of recurrence intervals for the southern margin." (Goldfinger et al., 2012).

Based on the available data and research for Salem the NHMP Steering Committee determined the **probability of experiencing an earthquake is “high,”** meaning one incident is likely within the next 35-year period.

Vulnerability Assessment

The effects of earthquakes span a large area. The degree to which earthquakes are felt, however, and the damages associated with them may vary. Earthquake damage occurs because humans have built structures that cannot withstand severe shaking. Buildings, airports, schools, and lifelines (highways, phone lines, gas, water, etc.) suffer damage in earthquakes and can ultimately result in death or injury to humans.

Based on the combination of local faults in the region, Salem’s proximity to the CSZ, potential slope instability, and prevalence of certain soils subject to liquefaction and amplification give the city a high-risk profile. Due to the expected pattern of damage resulting from a CSZ event, *The Oregon Resilience Plan* (2013) divides the State into four distinct zones and places Salem predominately within the “Willamette Valley Zone” (Valley Zone, from the summit of the Coast Range to the summit of the Cascades). 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.

Death and Injury

Earthquakes in the past caused no injuries regarding the health and safety of residents. However, the potential for injuries or deaths from past events or from similar events in other communities could escalate resulting in multiple deaths and major injuries. Death and injury can occur both inside and outside of buildings due to falling equipment, furniture, debris, and structural materials. Likewise, downed power lines or broken water and gas lines endanger human life. Death and injury are highest in the afternoon when damage occurs to commercial and residential buildings and during the evening hours in residential settings (LeDuc et al, 2000). It is estimated that 50-75% of the city's population would be physically displaced by an earthquake, accounting for the number of homes that would be damaged from seismic activity, and there would be extensive impact on community social networks.

Building Damage

Wood structures tend to withstand earthquakes better than structures made of brick or unreinforced masonry buildings (Wolfe et al., 1986). Building construction and design play a vital role in the survival of a structure during earthquakes. Damage can be quite severe if structures are not designed with seismic reinforcements or if structures are located atop soils that liquefy or amplify shaking. Whole buildings can collapse or be displaced. Most facilities throughout the city anticipate extensive damage due to an earthquake, estimated at more than $1 billion for hazard response, structural repairs and equipment replacement.

The DOGAMI *Multi-hazard Risk Report for Marion County, Oregon* (Williams et al., 2022) indicates that during a Mt. Angel Mw-6.8 deterministic[4] scenario, there is the potential to have 2,682 (4.2% population) displaced residents, 4,171 damaged buildings, 6 of which are critical facilities. The loss estimate is $ 1,176,844,018 (loss ratio of 8.7%).

Bridge Damage

Earthquake damage to roads and bridges can be particularly serious by hampering or cutting off the movement of people and goods and disrupting the provision of emergency response services. All bridges can sustain damage during earthquakes, leaving them unsafe for use. More rarely, some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link – damage to them can make some areas inaccessible.

Because bridges vary in size, materials, siting, and design, earthquakes will affect each bridge differently. Bridges built before the mid 1970's often do not have proper seismic reinforcements. These bridges have a significantly higher risk of suffering structural damage

[4] A deterministic scenario is based on a specific seismic event, such as a Cascadia Subduction Zone magnitude (Mw)-9.0 event. DOGAMI used the deterministic scenario method for this study along with the user-defined facility (UDF) database so that loss estimates could be calculated on a building-by-building basis. The Mt. Angel Fault deterministic scenario was selected as the most appropriate for communicating earthquake risk for Marion County (Williams & Madin, 2022).

during a moderate to large earthquake. Bridges built in the 1980's and after are more likely to have the structural components necessary to withstand a large earthquake (LeDuc et al., 2000).

Damage to Lifelines

Lifelines are the connections between communities and critical services. They include water and sewer lines, food suppliers, electricity and gas lines, communications, and transportation systems. Ground shaking and amplification can cause pipes to break open, power lines to fall, roads and railways to crack or move, and radio or telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. All lifelines need to be usable after an earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public (LeDuc et al., 2000).

Disruption of Critical Facilities

Critical facilities, also considered community lifelines, are police stations, fire stations, hospitals, other medical and social services, food and water suppliers, and shelters. These are facilities that provide services to the community and need to be functional after an earthquake event. The earthquake effects outlined above can all cause emergency response to be disrupted after a significant event (Wang & Clark, 1999).

As noted previously, the DOGAMI *Multi-hazard Risk Report for Marion County, Oregon* (Williamset al., 2022) indicates that during a Mt. Angel Mw-6.8 deterministic scenario, there is the potential to have 4,171 damaged buildings, 6 of which are critical facilities. The loss estimate is $ 1,176,844,018 (loss ratio of 8.7%).

Economic Loss

Seismic activity can cause great loss to businesses, either a large-scale corporation or a small retail shop. Losses not only result in rebuilding cost, but fragile inventory and equipment can be destroyed. When a company is forced to stop production for just a day, business loss can be tremendous. Residents, businesses, and industry all suffer temporary loss of income when their source of finances is damaged or disrupted. A major earthquake can separate businesses and other employers from their employees, customers, and suppliers thereby further hurting the economy. It is likely more than 75% of businesses located in the city and surrounding area would experience commerce interruption for a period of a year or longer.

Fire

The community energy and communication lifelines, such as power lines, gas lines, and telecommunication facilities can be damaged by an earthquake. Downed power lines or broken gas mains can trigger fires. When fire stations suffer building or lifeline damage, quick response to quench fires is less likely.

Natural Resources

Earthquakes would likely have extensive impacts on more than 75% of the city's ecological systems, including, clean water, wildlife habitat, and parks.

Debris

After damage occurs to a variety of structures, much time is spent cleaning up brick, glass, wood, steel or concrete building elements, office and home contents, and other materials. Following an earthquake event, the cleanup of debris can be a challenge for the community.

Figure 15 above shows the expected shaking/damage potential for Salem resulting from a CSZ earthquake event. The figure shows that the city will experience "very strong" to "severe shaking" that will last two to four minutes. The strong shaking will be extremely damaging to lifeline transportation routes including Interstate-5. For more information on expected losses due to a CSZ event see *The Oregon Resilience Plan* (2013).

The NHMP Steering Committee rated the city as having a **"high" vulnerability to an earthquake hazard**, meaning that more than 10% of the city's population or assets would be affected by a major earthquake emergency.

2007 Rapid Visual Survey

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). Rapid Visual Survey 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. To fully assess a building's potential for collapse, a more detailed engineering study completed by a qualified professional is required, but the RVS study can help to prioritize which buildings to survey.

DOGAMI surveyed 78 buildings in Salem. Buildings with a 'high' or 'very high' potential for collapse are listed in Table 6.

Table 6 City of Salem Building Collapse Potential

Level of Collapse Potential			
Low (<1%)	**Moderate (1-10%)**	**High (>10%)**	**Very High (100%)**
29	**9**	**33**	**7**

Source: Lewis, 2007

Of the facilities evaluated by DOGAMI using RVS, in Salem it included seven schools, seven government buildings and emergency services facilities (including the State Capital, Salem City Hall, and Oregon State Police), and 11 Chemeketa Community College buildings have a high collapse potential. The seven buildings with very high collapse potential are all School District 24-J buildings.

For reference, the DOGAMI *Multi-Hazard Risk Report for Marion County, Oregon* (Williams et al., 2022) identified the following critical facilities that would experience moderate to complete damage (>50% probability) from a Mt. Angel magnitude 6.8 earthquake. Overall, the potential includes 4.2% of residents displaced and 4,171 buildings damaged, including six critical facilities[5].

- Bush Elementary School[6]
- Chemawa Indian School
- Englewood Elementary School
- Hammond Elementary School
- Marion County Community Corrections
- Brush College Elementary School

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

[5] The 2023 Salem NHMP steering committee expanded their critical facilities list during the updating process, and which now includes all schools within its jurisdiction

[6] This report references the former Bush Elementary School that was built in 1936. According to the Statesman Journal, the original school was demolished in 2005 and replaced with a parking lot for the Salem Hospital (Zimmerman, 2014).

Extreme Heat

Significant Changes Since Previous Plan:

The Extreme Heat Hazard section was reformatted and expanded with additional information since the previous plan.

Causes and Characteristics

North American summers are hot; most summers see heat waves in one or more parts of the United States. East of the Rockies, they tend to combine both high temperature and high humidity; although some of the worst heat waves have been catastrophically dry, according to NOAA's *Heat Wave: A Major Summer Killer*.

Climate conditions in the Willamette Valley, which Salem is located, are described as Mediterranean, with rainy winters and warm dry summers. Extreme temperatures aren't as common in western Oregon compared to other parts of the state. However, the Willamette Valley experiences days above 90°F nearly every year. The frequency of prolonged periods of high temperatures is expected to increase.

The definition of extreme heat varies by region; however, in general a heat wave is a prolonged period of extreme heat for several days to several weeks. High temperatures are also often combined with excessive humidity, according to FEMA's *Are You Ready? 2.6 Extreme Heat*. Heat is considered the silent killer, affecting the lives and health of people across the country. According to the Centers for Disease Control and Prevention, an average of 702 heat-related deaths occurs each year in the U.S (NOAA, Excessive heat, a 'silent killer', 2014). Heat is the number one weather-related killer in the United States, resulting in hundreds of fatalities each year. In fact, on average, excessive heat claims more lives each year than floods, lightning, tornadoes and hurricanes combined (NOAA, *Heat Wave: A Major Summer Killer*).

According to NOAA's Heat Index, heat waves form when high pressure aloft (approximately 10,000 to 25,000 feet above the earth surface) strengthens and remains over a region for several days up to several weeks. This is common in summer. Weather patterns in the summer are slower to change, generally, compared to winter, and thus the mid-level high pressure also moves slowly. Under high pressure, the air subsides or sinks toward the earth surface. This sinking air acts as a dome capping the atmosphere. This cap then traps heat instead of allowing it to rise, which limits convection. The result is a build-up of heat at the earther's surface.

Location and Extent

The most severe impact of extreme heat affects peoples' health directly. Most heat disorders occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. Older adults, young children, and those who are sick or overweight are more likely to succumb to extreme heat (FEMA, *Are You Ready? 2.6 Extreme Heat)*.

According to the FEMA, “[C]onditions that can induce heat-related illnesses include stagnant atmospheric conditions and poor air quality. Consequently, people living in urban areas may be at greater risk from the effects of a prolonged heat wave than those living in rural areas. Also, asphalt and concrete store heat longer and gradually release heat at night, which can produce higher nighttime temperatures known as the “urban heat island effect” (FEMA, *Are You Ready? 2.6 Extreme Heat)*.

With respect to extreme heat, the *Fifth Oregon Climate Assessment* (2021) by OCCRI states,

> The frequency and magnitude of days that are warmer than 90°F is increasing across Oregon. During summer, relative increases in nighttime minimum temperatures have been greater than those in daytime maximum temperatures. The frequency, duration, and intensity of extreme heat events is expected to increase throughout the state during the twenty-first century.

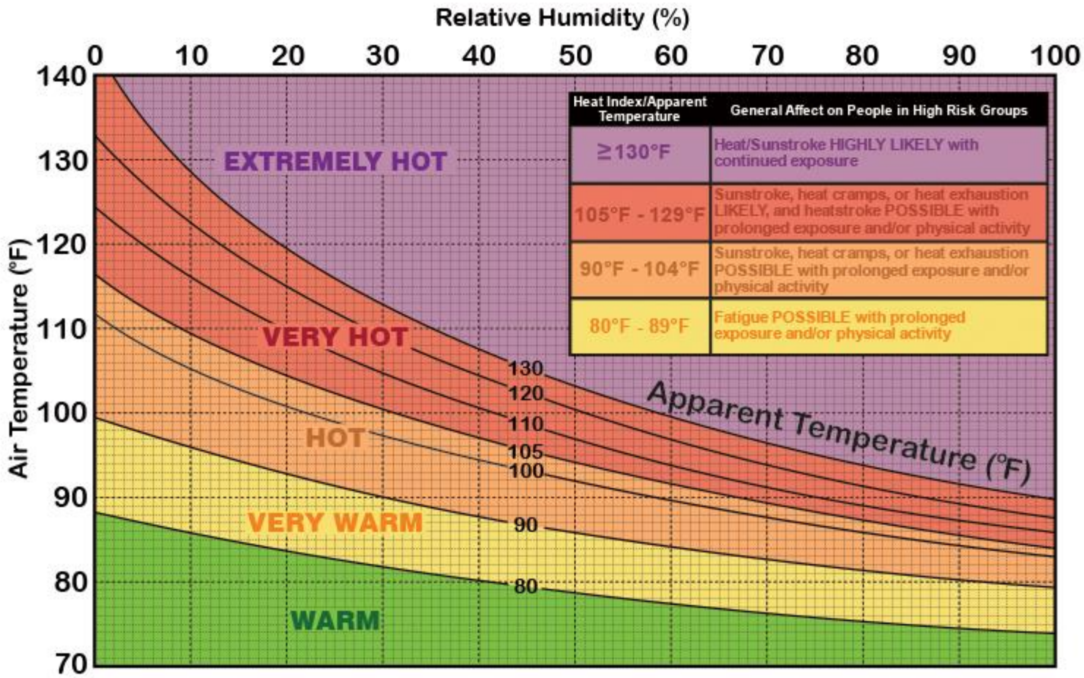
Identifying Excessive Heat

NOAA's heat alert procedures are based mainly on Heat Index Values. The Heat Index, sometimes referred to as the apparent temperature, is given in degrees Fahrenheit. The Heat Index is a measure of how hot it really feels when relative humidity is factored with the actual air temperature.

To find the NOAA Heat Index temperature, look at the Heat Index chart below. These values are for shady locations only. Exposure to full sunshine can increase heat index values by up to 15°F (8°C). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous as the wind adds heat to the body. As an example, if the air temperature is 96°F and the relative humidity is 65%, the heat index--how hot it feels--is 121°F. The National Weather Service will initiate alert procedures when the Heat Index is expected to exceed 105˚-110˚F (depending on local climate) for at least two consecutive days (NOAA, *Heat Wave: A Major Summer Killer)*.

NOAA issues for excessive heat outlooks for periods of 3-7 days and 8-14 days in advance and provides hourly forecasts, advisories, watches and warnings when dangerous heat becomes likely or imminent.

Figure 22 Heat Index



Source: National Oceanic and Atmospheric Administration, 2023

History

In June 2021, a high-pressure heat dome over the region led to a 3-day stretch of extreme heat from June 26 - 29. Heat advisories were issued across the Pacific Northwest with record highs warming over 100 degrees Fahrenheit with a record-breaking temperature up to 117 degrees recorded in Salem. A total of 123 heat related deaths were reported in the Pacific Northwest resulting from limited access to air-conditioning and an increase in the number of drownings. Widespread business closures and event postponements also occurred. Heat continued into August 2021, with temperatures peaking a second time at 105 degrees, according to NOAA Storm Event Database for Oregon. Oregon Governor issued an Emergency Declaration due to forecasted heat across the State affecting 23 counties.

Prior to this event, in July 2009 heat advisories were issued across the Pacific Northwest, with record highs of 107 degrees Fahrenheit in Salem, 106 degrees in Portland and over 100 degrees in Seattle. Extreme heat also affected Salem in June 2015, with additional minor occurrences annually.

Table 7 provides heat and excessive heat events reported from 2017-2022.In some cases, the heat wave lasted several days, which is unusual for the region. Many homes and buildings throughout Northern Oregon and Washington do not have air-conditioning, because temperatures are generally moderate in this region. Cooling centers were open in cities and communities throughout the Pacific Northwest.

Table 7 Heat and Excessive Heat Events in Marion and Polk Counties 2017-2022

Zone	Begin Date	Begin Time	Event Type	Deaths
NORTH OREGON CASCADES (ZONE)	5/22/2017	1200	Heat	0
CENTRAL WILLAMETTE VALLEY (ZONE)	8/1/2017	1200	Excessive Heat	0
CENTRAL WILLAMETTE VALLEY (ZONE)	7/18/2018	700	Heat	0
CENTRAL WILLAMETTE VALLEY (ZONE)	8/16/2020	700	Heat	0
CENTRAL WILLAMETTE VALLEY (ZONE)	8/17/2020	800	Heat	0
NORTH OREGON CASCADES FOOTHILLS (ZONE)	6/26/2021	1000	Excessive Heat	2
CENTRAL WILLAMETTE VALLEY (ZONE)	6/26/2021	1200	Excessive Heat	16
CENTRAL WILLAMETTE VALLEY (ZONE)	7/29/2021	1400	Heat	0
CENTRAL WILLAMETTE VALLEY (ZONE)	8/11/2021	1400	Excessive Heat	0
NORTH OREGON CASCADES (ZONE)	8/11/2021	1400	Excessive Heat	0
NORTH OREGON CASCADES FOOTHILLS (ZONE)	8/11/2021	1400	Excessive Heat	0

Source: National Oceanic and Atmospheric Administration

Future Climate Projections

It is extremely likely (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (very high confidence). Extreme temperatures are relatively rare in the region but are projected to increase under future climate change.

As noted previously, in Marion 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 (RCP 4.5) and higher (RCP 8.5) emissions scenarios. In particular, the number of days per year with temperatures 90°F or higher is projected to increase by an average of 16 days (range 5–27 days) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario. In addition, 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, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

The *Salem Climate Action Plan 2021*, includes numerous strategies to address a variety of climate-related challenges facing the city including heat and extreme heat. The plan acknowledges significant projected climate impacts including the following:

- The number of days with a heat index over 90°F will increase from a historic average of 7 per year to 33 per year by mid-century.
- Hotter and drier conditions are likely to cause more frequent droughts.

Probability Assessment

Based on the available data and research for Salem the NHMP Steering Committee determined the **probability of experiencing an extreme heat event is "high,"** meaning one incident is likely within the next 35-year period

Vulnerability Assessment

Extreme heat requires the body to work extra hard to maintain a normal temperature, which can lead to death. Extreme heat is responsible for the highest number of annual deaths among all weather-related hazards. Older adults, children and sick or overweight individuals are at greater risk from extreme heat, according to FEMA.

Extreme heat events in the past caused few minor injuries to the health and safety of Salem residents. However, the potential for injuries or deaths in future events could escalate increasing the occurrence and seriousness of possible injuries or death. During the June 2021 extreme heat event, a total of 123 heat related deaths in the Pacific Northwest were reported resulting from limited access to air-conditioning and an increase in the number of drownings when residents sought relief in bodies of water. Widespread business closures and event postponements occurred. It is estimated that approximately 10% of Salem's population would be physically displaced by an extreme heat event, likely those individuals who seek refuge in a cooling center, and there would be mild impact on community social networks.

According to the Agency for Toxic Substances and Disease Registry (in collaboration with the Center for Disease Control and Prevention) 2020 Social Vulnerability Index (SVI), social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties. Polk County, which includes the western area of Salem, has a low-medium SVI. Marion County ranks in about the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than "well."

Facilities throughout the city are anticipated to reflect little to no damage due to extreme heat, estimated at less than $1 million for hazard response, structural repairs and equipment replacement. In terms of commercial business, it is likely 10-30% of businesses located in the City and surrounding area would experience commerce interruption for a period of at least a few days. Extreme heat has the potential to overload the electric grid and result in widespread power outages. Lastly, extreme heat would likely have mild impacts on 10-25% of the city's ecological systems, including, clean water, wildlife habitat, and parks.

Salem Climate Action Plan 2021

The *Salem Climate Action Plan 2021* outlines the following potential vulnerabilities and consequences of various projected climate changes as it relates to extreme heat events.

Projected Temperature Increases

While higher summer temperatures may lead to health impacts for vulnerable populations, the temperature increase is not projected to be extreme and may be offset by people's ability to naturally acclimate to changing temperatures over time.

- Increased risk of heat-related illnesses to small children, the elderly, people with chronic illnesses, residents living at or near the poverty line, and people who work outside (e.g., farmworkers and construction workers), and people who are unsheltered.
- Increased risk of respiratory problems.
- Salem's population is expected to grow 28% by 2035. Combined with warming temperatures, increases in population mean more people will likely use air conditioning on the warmest days, which may lead to an increased demand for electricity.
- Warming temperatures may allow for new pests to infiltrate the area. New pests may have the ability to negatively impact Salem's ecosystems, for example by harming the Salem's tree canopy and spreading disease.

Projected Precipitation Patterns

Though overall precipitation amounts are expected to remain consistent, increased temperatures noted above will lead to a water deficit.

- Increased risk of drought, especially when combined with warmer temperatures.
- Water use restrictions and food insecurity in periods of drought.

As such, the NHMP Steering Committee rated the city as having a **"high" vulnerability to extreme heat hazards**, meaning that more than 10% of the city's population or property would be affected by a major disaster.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

Flood

Significant Changes Since Previous Plan:

The Flood Hazard section was reformatted and expanded with additional information since the previous plan.

Causes and Characteristics

Flooding results when climate or weather patterns (e.g., rain and snowmelt) combined with geology and hydrology creating water flows that exceed the carrying capacity of rivers, streams, channels, ditches, and other watercourses. These factors, combined with ongoing development can create seasonal flooding conditions. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall. Most of Oregon's destructive natural disasters have been floods (Taylor & Hannan, 1999). According to the Salem *Floodplain Management Plan* (2018), Salem receives approximately 38 inches of rain on average each year.

Flooding can be aggravated when rain is accompanied by snowmelt and frozen ground; the spring cycle of melting snow is the most common source of flood in the region. Statewide, the most damaging floods have occurred during the winter months, when warm rains from tropical latitudes melt mountain snowpacks. Lesser flooding has been associated with ice jams, normal spring run-off, and summer thunderstorms. Heavily vegetated stream banks, low stream gradients, and breeched dikes have contributed to past flooding at considerable economic cost.

Types of Floods

The principal types of floods that occur in Salem include riverine floods, shallow area floods, and urban floods.

Riverine Flooding

Riverine floods occur when water levels in rivers and streams overflow their banks. Most communities located along such water bodies have the potential to experience this type of flooding after spring rains, heavy thunderstorms or rapid runoff from snow melt. Riverine floods can be slow or fast rising, but usually develop over a period of days. The danger of riverine flooding occurs mainly during the winter months, with the onset of persistent, heavy rainfall, and during the spring, with melting of snow.

As noted in the Salem *Floodplain Management Plan* (2018), the City of Salem features the Willamette River, smaller tributaries, and streams that are susceptible to annual flooding events that pose threats to life and safety and cause significant property damage. The streams include Battle Creek, Cinnamon Creek, Claggett Creek, Clark Creek, Croisan Creek, Davidson Creek, Gibson Creek, Glenn Creek, Golf Creek, Jory Creek, Laurel Creek, Little Pudding, Mill Creek, Mill Race, Pettijohn Creek, Powell Creek, Pringle Creek, Scotch Creek, Shelton Ditch, Waln Creek, and Winslow Creek. Salem's flood events often occur when warm weather and heavy rains melt snow at higher elevations which flood local streams.

Shallow Area Floods

These floods are a special type of riverine flooding. FEMA defines a shallow area flood hazard as an area that is inundated by a 100-year flood with a flood depth between one to three feet. Such areas are generally flooded by low velocity sheet flows of water.

Urban Floods

Urban floods occur when there is an inundation of land in a built environment, particularly in densely populated areas. It happens when rainfall overwhelms the capacity of drainage systems. According to the Center for Neighborhood Technology's *The Prevalence and Cost of Urban Flooding* (2014), although sometimes triggered by events such as flash flooding or snowmelt, urban flooding is a condition, characterized by its repetitive and systemic impacts on communities, which can happen regardless of whether the affected community is located within designated floodplains or near any body of water.

Other Flood Hazards

Flood is one of the identified climate change metrics in OCCRI's analysis that is included in the 2020 Oregon NHMP for the Mid/Southern Willamette Valley (Region 3). Region 3 includes Linn, Lane (non-coastal), Marion, Polk, and Yamhill Counties.

Furthermore, flooding and landslides are projected to occur more frequently throughout western Oregon. According to the 2020 Oregon NHMP for Region 3, it is very likely (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (high confidence) that is more likely (>50%) to lead to an increase in the incidence and magnitude of damaging floods (low confidence). Because landslide risk depends on a variety of site-specific factors, it is more likely (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.

The Salem *Floodplain Management Plan* (2018) identifies levees and dams as other flood hazards. Dam failure, together with High Hazard Potential Dams (HHPD) that could impact Salem, is addressed below in the Dam Failure section of the Flood Hazard. Otherwise, the *Floodplain Management Plan* (2018) states the following about levees,

> **Inventory of Levees**
>
> The Keizer River Wall protects the City of Keizer from Willamette River flooding. This wall was inspected by the US Army Corps of Engineers in 2010, as described in an inspection report titled *Keizer River Wall, Flood Damage Reduction Project, Periodic Inspection No. 1.* Because this flood wall is located sufficiently downstream of Salem to prevent backwater effects, this flood protection measure does not appear to affect the flood hazards within the city limits of Salem.
>
> The FIS describes that an earthen berm protects the Sun Retirement Center along West Fork Pringle Creek at 12th Street SE. This berm appears to restrict localized flooding for one property along 12th Street Cutoff SE.

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.

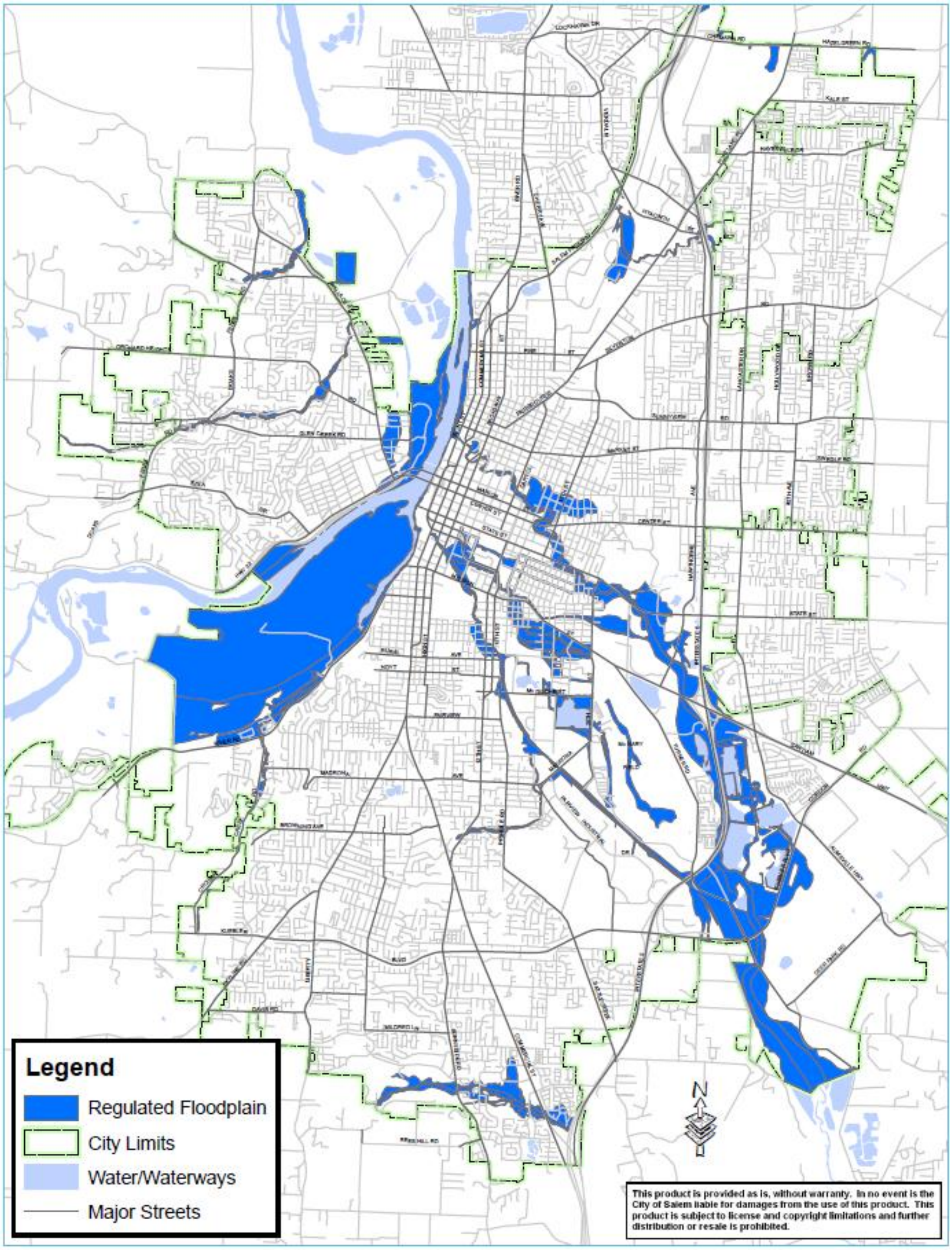
The magnitude of flood used as the standard for floodplain management in the United States is a flood having a probability of occurrence of 1 percent in any given year. This flood is also known as the 100-year flood or base flood. The most readily available source of information regarding the 100-year flood is the system of Flood Insurance Rate Maps (FIRM) 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 flood insurance and floodplain management requirements.

According to the Salem *Floodplain Management Plan* (2018), the city has more than 4,000 acres of floodplain and approximately 3,000 individual parcels that are partially or entirely located within the floodplain. The most significant of the FEMA-determined floodplains and floodways either surround the southern side of the Willamette River west of Salem or are within the greater Mill Creek/Pringle Creek watershed.

Properties in and near the floodplains in the City of Salem are subject to frequent flooding events. Since flooding is such a pervasive problem throughout the city, many residents have purchased flood insurance to help recover from losses incurred from flooding events. Figure 23 and Figure 30 illustrate the regulate floodplain and special flood hazard areas.

Monitoring stream levels and rainfall in near real-time, which is done from several sites across Salem and throughout the Mill Creek Watershed. The Willamette River has a river gauge is located at the base of the Center Street Bridge and can be electronically read on the National Weather Service website. Similarly, the gauges are also on Mill Creek, Battle Creek, Clark Creek, Waln Creek, Pringle Creek, Shelton Ditch, and Glenn Creek. The electronic read provides for seven days of actual river or stream depth and flow history and seven days of future forecast as reported by the National Weather Service. The gauges also have the action stage, flood stage, moderate flood stage, and major flood stage on the chart so an individual can see immediately where the river is in reference to potential flooding. This gauge provides the city with up-to-date river levels that it can use to determine the immediate impact to the community. Using the seven-day forecast portion of the gauge provides the city the opportunity to plan for future impacts that flooding may have on specific portions of the city depending on river flood stages and city elevations.

Figure 23 Salem Regulated Floodplain



Source: City of Salem, 2018.

Dam Failure

The Oregon Water Resources Department is the state authority for dam safety with specific authorizing laws and implementing regulations. Oregon's dam safety laws were rewritten by

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 Dam Safety Program also coordinates with the National Weather Service and the Oregon Office of Emergency Management on severe flood potential that could affect dams and other infrastructure.

The OWRD has been striving to inspect the 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.

Causes and Characteristics of Dam Failure

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. 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.

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.

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 confirm such design.

However, there are several dams where observations, and sometimes analysis indicates a deficiency that may make those dams susceptible to one or more of the events. Most of the 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 2000 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 persons perished. In modern times (2006) a dam owner filled in the spillway of a dam on the island of Kauai causing dam failure that killed 7 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.

According to the 2020 Oregon NHMP, the state has records of at least 55 dam failures in the State. Many of these failures had very little or no impacts on people, structures, or properties. Of these, 21 dams had more serious to tragic effects (Table 53, 2020 Oregon NHMP) and included 16 east of the Cascade Range, 3 in southern and coastal Oregon (Jackson and Coos County), and 2 in the Willamette Valley region (Linn County and Marion County).

Regarding 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 EAPs, 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 the Dam Safety Program priority; therefore, hazard ratings can and do change. Ratings may change for several 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.

Salem Dam Safety Issues

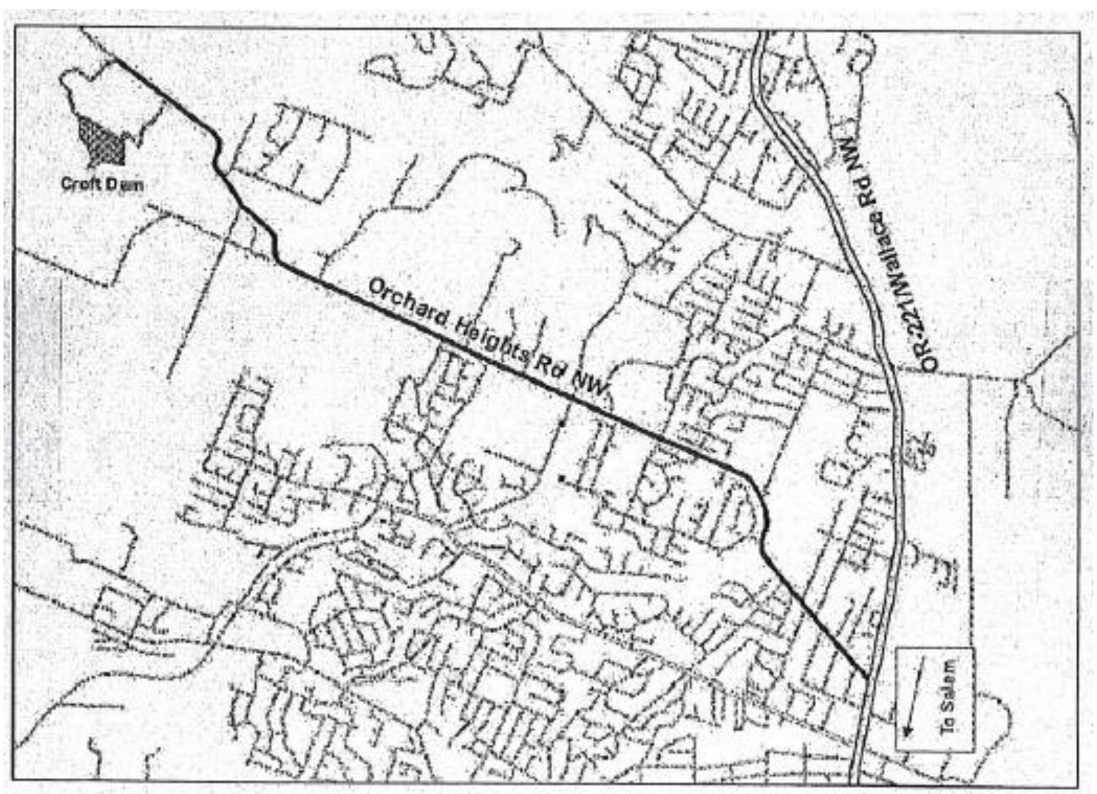
There are two High Hazard Potential Dams – Croft and Franzen – regulated by Oregon that, if they were to fail, could impact to Salem. These two dams, either within or close proximity of city limits, are assigned a hazard rating based on downstream hazard to people and property, not on the condition of the dam. The following is a brief description of the two dams.

Croft Dam

Croft dam is located within city limits, west of the Willamette River in Polk County. Croft Reservoir Dam is approximately 43 feet in height and in satisfactory condition. The OWRD Dam Safety Program has an Emergency Action Plan (EAP) for Croft, which includes an inundation map. According to the Croft EAP, "Croft Dam has been well maintained and it has a high maintenance and construction history."

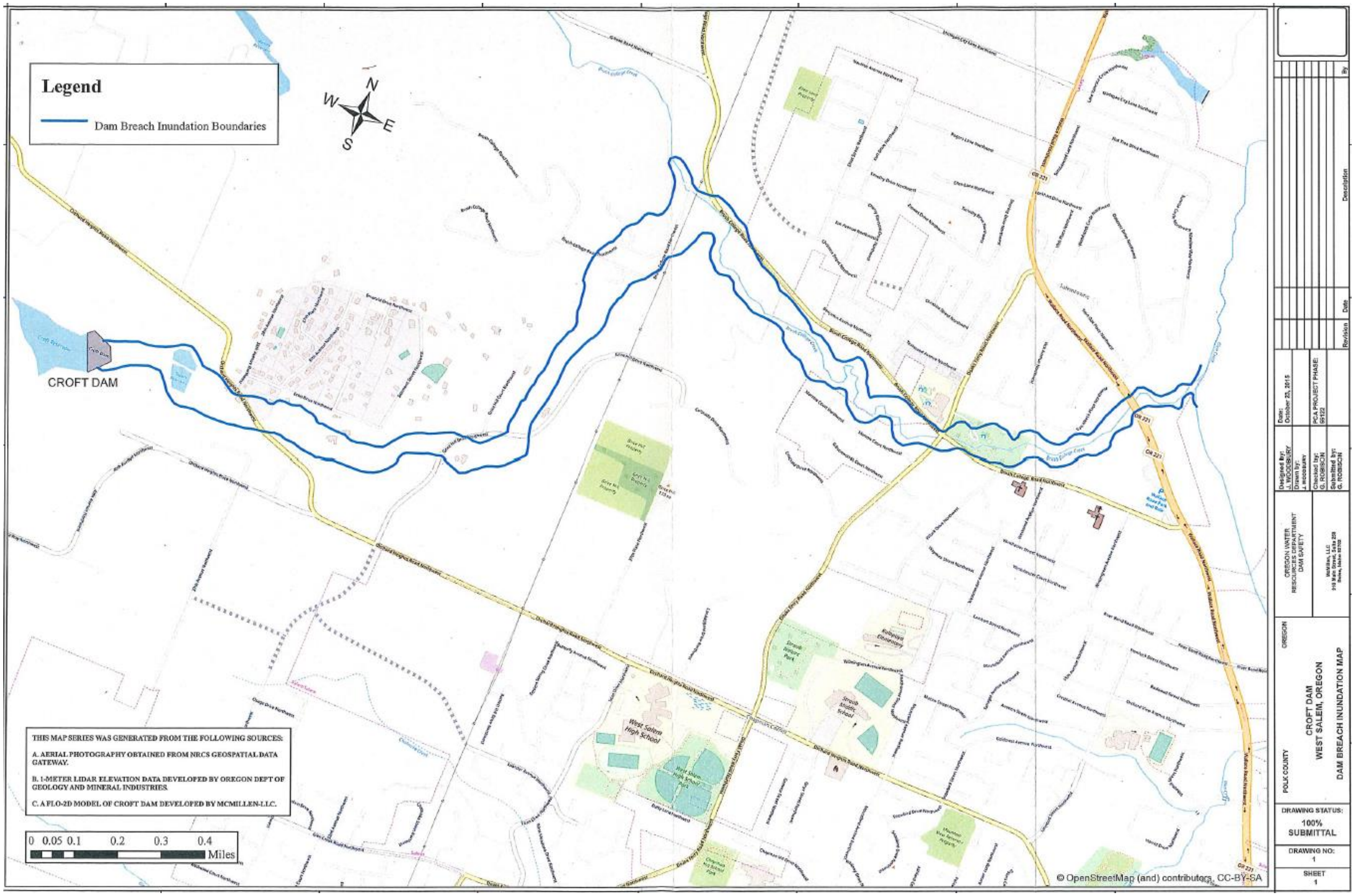
The following includes the Croft dam location and inundation maps.

Figure 24 Croft Dam Location



Source: City of Salem, 2018 (*Emergency Action Plan for Croft Reservoir Dam)*

Figure 25 Croft Dam Inundation Map



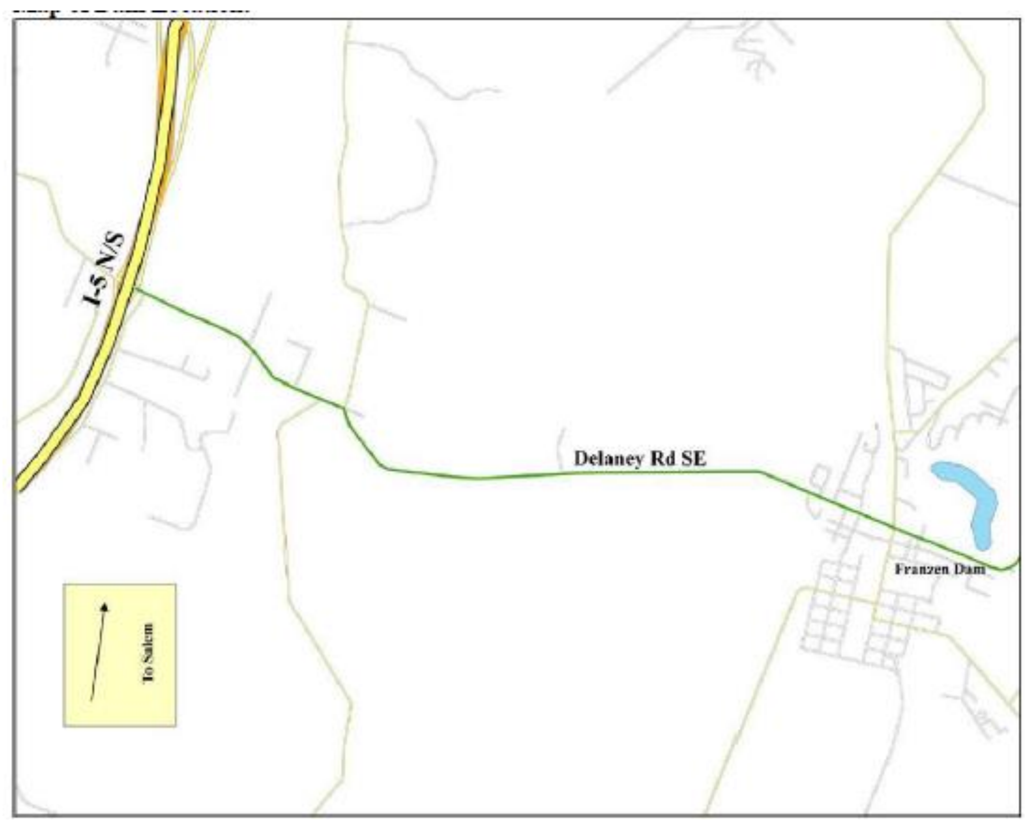
Source: City of Salem, 2018 (*Emergency Action Plan for Croft Reservoir Dam)*

Franzen Dam

Franzen dam is located outside city limits near the City of Turner and is used for water supply. Franzen dam is in satisfactory condition. Although Franzen dam is out the city limits of Salem, and its loss would not inundate within Salem's city limits[7] but would affect or possibly eliminate water supply for Salem. The OWRD Dam Safety Program has an EAP for Franzen, which includes an inundation map.

The following two maps show the Franzen dam location and inundation map.

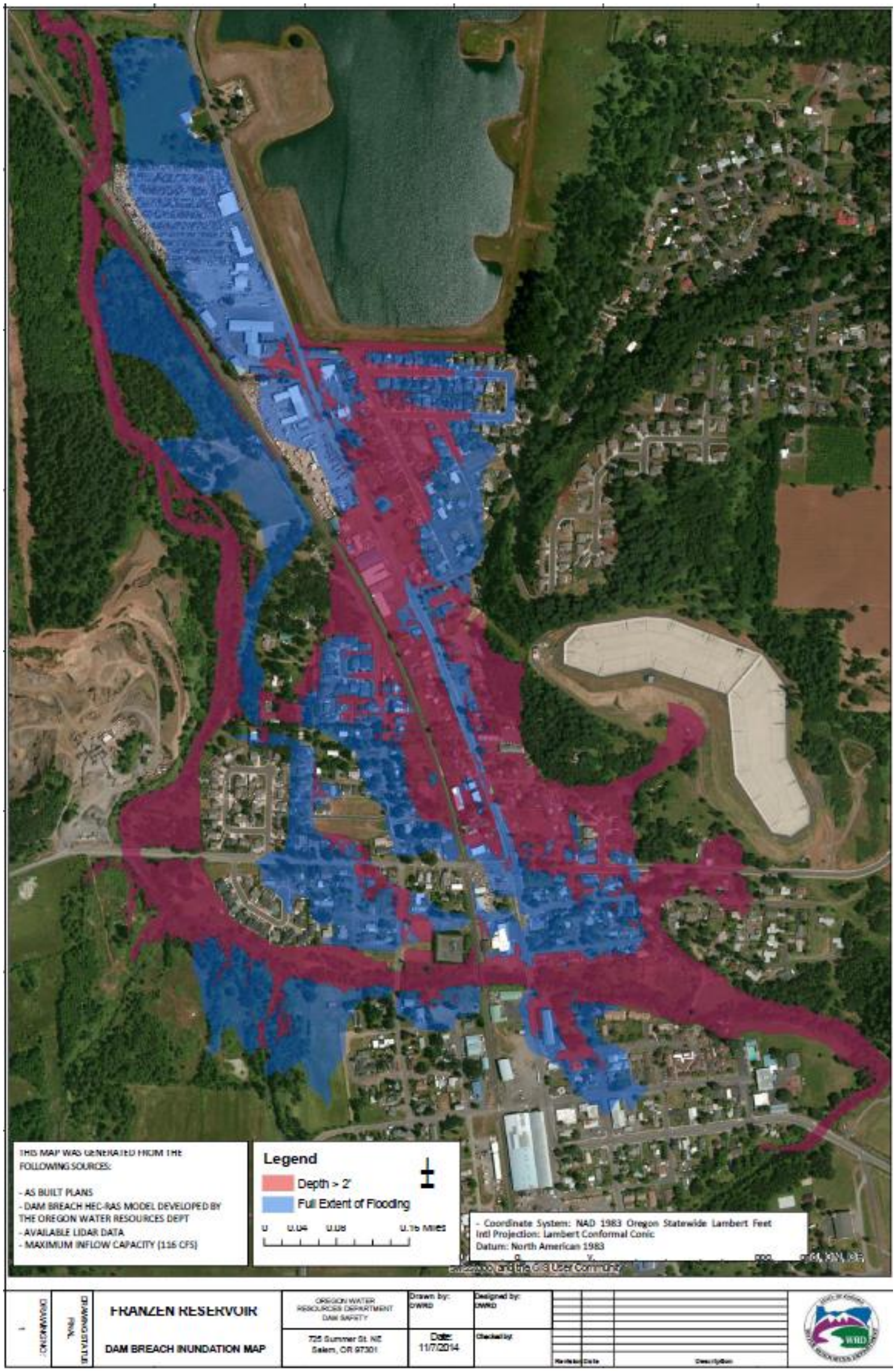
Figure 26 Franzen Dam Location



Source: City of Salem, 2019 (*Emergency Action Plan for Franzen Dam)*

[7] According to the Franzen EAP, "Dam failure may inundate numerous areas of subdivisions north of Delaney Road east of Turner Road, and homes between the reservoir and Mill Creek."

Figure 27 Franzen Dam Inundation Map



Source: City of Salem, 2019 (*Emergency Action Plan for Franzen Dam)*

The Salem *Floodplain Management Plan* (2018) identifies two other HHPDs that could impact Salem. Big Cliff Dam is federally regulated and produces hydropower. Detroit dam is also a HHPD but is identified in the National Inventory of Dams as being in Linn County. The plan states,

> **Inventory of Dams**
>
> The *Marion County, Oregon, Multi-Jurisdictional Natural Hazard Mitigation Plan* identifies two dams with high hazard potential—Big Cliff Dam and Detroit Dam—that are located on the North Santiam River, which ultimately discharges into the Willamette River upstream of Salem.
>
>> *Dams play a crucial role in power generation and water control mechanisms for the region. 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 located across Marion County and Salem. The "hazard level" estimates the amount of damage that could occur in the event of dam failure.*
>>
>> *Marion County has over 56 dams, and two are ranked at a high hazard level: Detroit Dam and Big Cliff Dam. Detroit and Big Cliff are hydroelectric dams that control the flow of water on the Santiam River, providing a major boating and recreational area. However, both dams are considered a major hazard for the large population downstream that would be at risk in the event of a dam failure, including populations in Salem. Besides the Detroit and Big Cliff dams, other major dams surrounding the Salem area include Waconda and Silverton* (Salem Natural Hazard Mitigation Plan, 2017, p. C-32).

Flood Terminology

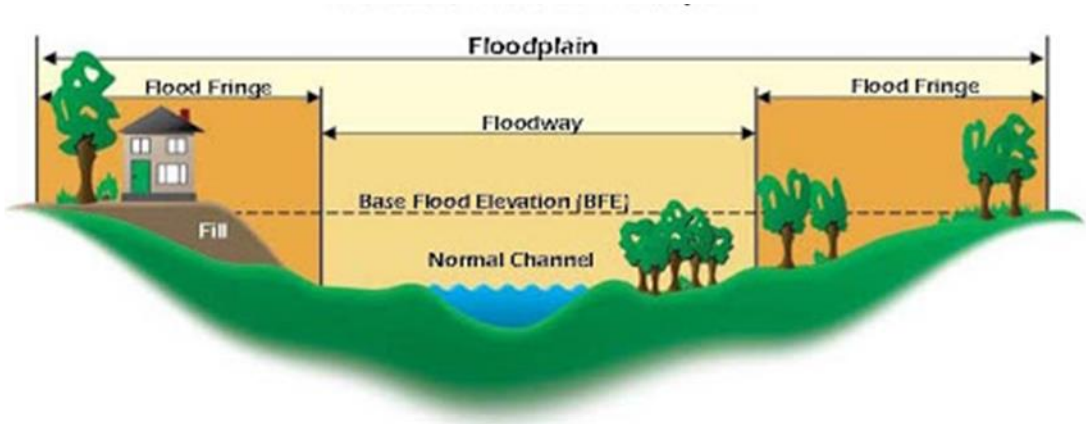
Floodplain

A floodplain is land adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. These areas, if left undisturbed, act to store excess floodwater. The floodplain is made up of two areas: the flood fringe and the floodway.

Floodway

The floodway is the portion of the floodplain that is closer to the river or stream. For the NFIP and regulatory purposes, floodways are defined as the channel of a river or stream, and the over-bank areas adjacent to the channel. Unlike floodplains, floodways do not reflect a recognizable geologic feature. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. The NFIP regulations require that the floodway be kept open and free from development or other structures, so that flood flows are not obstructed or diverted onto other properties. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot…." Floodways are not mapped for all rivers and streams but are typically mapped in developed areas.

Figure 28 Special Flood Hazard Area Schematic



Source: Oregon Department of Geology and Mineral Industries

Flood Fringe

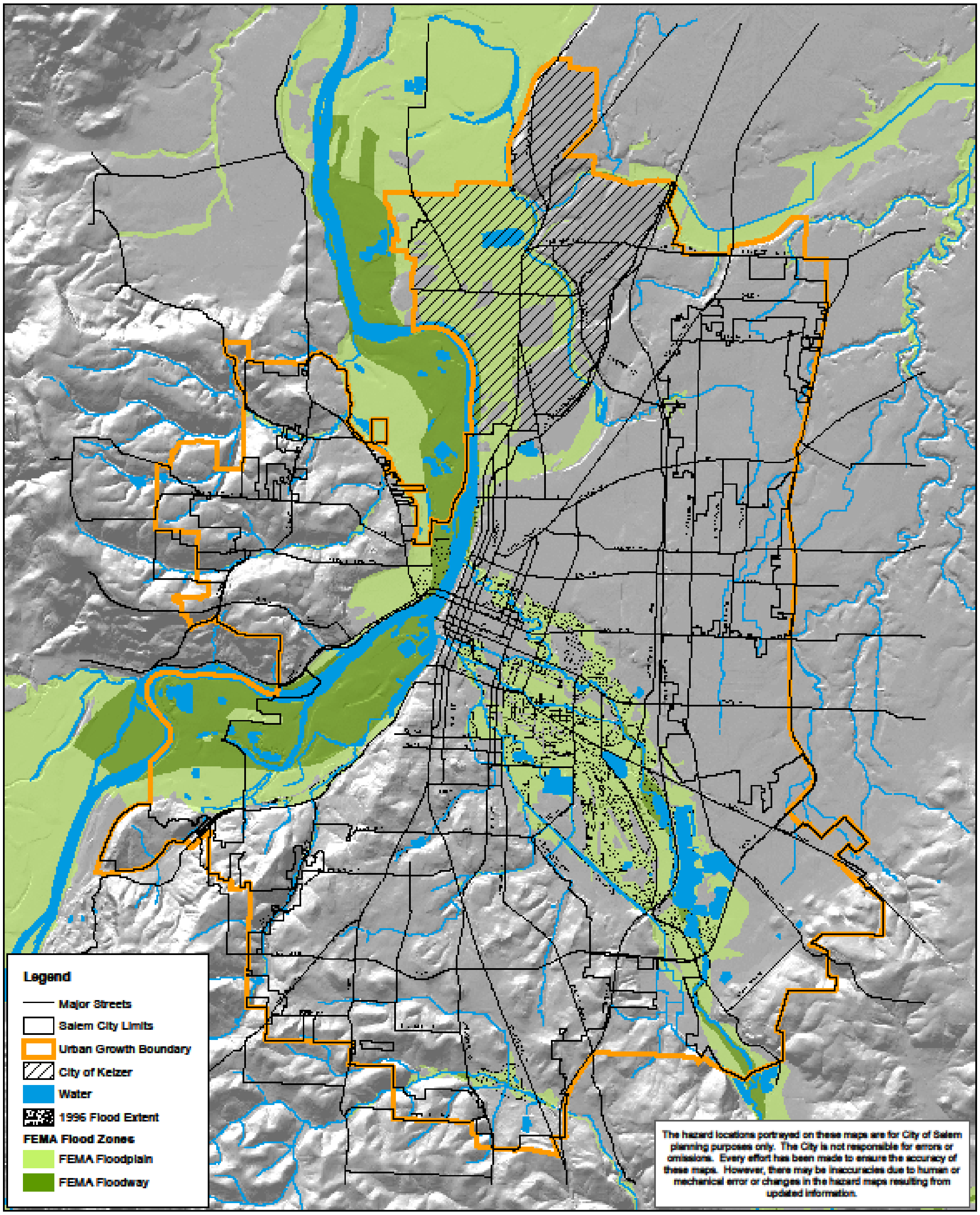
The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

Base Flood Elevation

Base Flood Elevation (BFE) means the water surface elevation during the base flood in relation to a specified datum or benchmark. The BFE is depicted on the FEMA Flood Insurance Rate Map to the nearest foot and in the Flood Insurance Study to the nearest 0.1 foot. The BFE is a baseline pulled together from historic weather data, local topography, and the best science available at the time. It's a reasonable standard to insure against, but it is not a guarantee that it will flood only one time every 100 years.

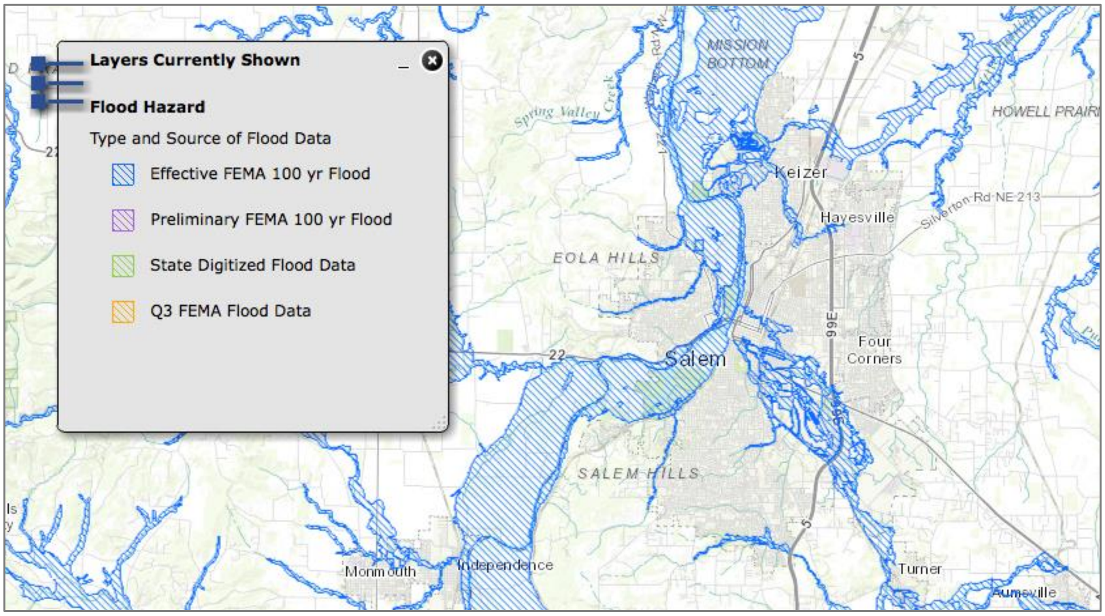
The special flood hazard that identifies the location and extent of the flood hazard is included below in Figure 30 and Figure 31.

Figure 29 Salem Special Flood Hazard Areas



Source: City of Salem

Figure 30 Special Flood Hazard Area



Source: Oregon Department of Geology and Mineral Industries, Oregon HazVu

History

Salem has more than 4,000 acres of floodplain and approximately 3,000 individual parcels that are partially or entirely located within the floodplain. In Salem, flooding generally occurs when: (1) unusually warm weather mixed with heavy rain melts snow in the higher elevations and flood local streams, and/or (2) ongoing development within the City continues to displace natural areas that have historically functional as flood storage.

According to the 2020 Oregon NHMP and the NOAA Storm Event Database, following is a table of significant historic floods affecting the Mid/Southern Willamette Valley. Many of the listed events impacted Salem.

Table 8 Significant Historic Floods Affecting Mid/Southern Willamette Valley

Date	Location	Characteristics	Type of Flood
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	Rain on snow; snow melt
Jan. 1881	Willamette Basin	Lane, Linn, Benton, Marion, Polk, Yamhill, Clackamas, Multnomah Counties	
Feb. 1890	Willamette Basin and coastal rivers	Second largest known flood in the Willamette Basin; almost every large bridge washed downstream	Rain on snow
Dec. 1937	Western Oregon	Flooding followed heavy rains; considerable highway flooding; landslides	Rain on snow
Jan. 1953	Western Oregon	Widespread flooding in western Oregon accompanied by windstorm	Rain on snow
Dec. 1964 – Jan. 1965	Willamette Basin	Record 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; $34 million in damages	Rain on snow

Date	Location	Characteristics	Type of Flood
Jan. 1974	Western Oregon	Flooding followed heavy wet snow and freezing rain; nine counties received Disaster Declaration	Rain on snow
Dec. 1978	Western Oregon	Intense heavy rain, snowmelt, saturated ground; one fatality in Region 3 (Benton County)	Rain on snow
Feb. 1986	Statewide	Severe statewide flooding; rain and melting snow; numerous homes flooded and highways closed	Snow melt
Feb. 1987	Western Oregon	Willamette River and tributaries; mudslides; damaged highways and homes	Rain on snow
Feb. 1996	Statewide	Deep snowpack, warm temperatures, record-breaking rains; flooding, landslides, power-outages (FEMA-1099-DR-Oregon)	Rain on snow
Nov. 1996	Statewide	Record-breaking precipitation; local flooding/landslides (FEMA-1149-DR-Oregon)	Rain on snow
Dec. 2005	Polk, Marion, Linn, Lane and Benton Counties	Heavy rains causing rivers to crest above flood stage in Polk, Marion, Linn, Lane, and Benton Counties, as well as other counties in the Willamette Valley	Riverine
Jan. 2006	Willamette Valley	Heavy rains caused many rivers to crest above flood stage in the Willamette Valley, causing road closures and damage to agricultural lands	Riverine
Dec. 2007	Yamhill County	South Yamhill River flooded near McMinnville, causing damage to roads and bridges, 120 homes in Sheridan along with a few businesses and churches, and causing minor damage in Willamina; total county-wide damage estimates at $9.6 million	Riverine
Dec. 2007	Polk County	Major flooding in Suver and other areas in Polk County; total losses equal $1 million for entire county	Riverine
Jan. 2012	Polk, Marion, Yamhill, Lincoln, Benton, Linn and Lane Counties	Heavy rain and wind; ice; flooding in the Willamette Valley; 130 homes and seven businesses were damaged in the City of Turner; 29 streets were closed in the City of Salem; the state motor pool lost 150 vehicles and thousands of gallons of fuel; Thomas Creek in the City of Scio overtopped, damaging several buildings. (FEMA-4055-DR-Oregon)	Riverine
Nov. 2012	Curry, Josephine and Lane Counties	Heavy precipitation; the Curry Coastal Pilot reported over 2 million dollars in infrastructure damage in Brookings and another 2 million in Curry County due to recent heavy rains; sinkholes and overflowing sewage facilities were also reported; according to KVAL news, Eugene Public Works has opened its emergency command center to deal with numerous flooding incidents, including two flooded intersections	Riverine
Feb. 2014	Lane, Coos, Marion and Tillamook and Counties	A series of fronts resulted in a prolonged period of rain for Northwest Oregon, and minor flooding of several of the area's rivers from February 12–17. Heavy rains caused the Coquille River at Coquille to flood. The flood was categorized as a moderate flood. The Nehalem River near Foss in Tillamook County exceeded flood stage on February 18th, 2014. Floods occurred in Salem which impacted roads and other city infrastructure. (FEMA-4169-DR-Oregon)	Riverine and urban flooding
Dec. 2014	Tillamook, Lincoln, Lane, Polk, Clackamas, Benton Coos and Douglas Counties	A slow moving front produced heavy rain over Northwest Oregon which resulted in the flooding of eight rivers. Another impact from the rain were a couple of land/rock slides that both blocked two highways. Heavy rain brought flooding to several rivers in southwest Oregon.	Riverine

Date	Location	Characteristics	Type of Flood
Dec. 2015	Tillamook, Lincoln, Washington, Clackamas, Multnomah, Lane, Columbia, Hood River, Polk, Coos, Douglas, Jackson and Curry Counties	A moist pacific front produced heavy rainfall across Northwest Oregon which resulted in river flooding, urban flooding, small stream flooding, landslides, and a few sink holes. After a wet week (December 5-11), several rivers were near bank full ahead of another front on December 12th. Flooding from the Nehalem River and Rock Creek in Vernonia resulted in evacuation of homes and the implementation of the Vernonia Emergency Command Center. Heavy rain resulted in a land slide that closed OR47 at mile marker 8. More than $15 million dollars in property damage reported in these counties combined. Floods occurred in Salem which impacted roads and other city infrastructure. (FEMA-4258-DR-OR)	Riverine, coastal, and urban flooding
Nov. 2016	Columbia, Tillamook, Lincoln, Benton, Washington, Polk and Yamhill Counties	A moist Pacific front moving slowly across the area produced heavy rainfall, resulting in flooding of several rivers across Northwest Oregon and at least two landslides.	Riverine
Feb. 2017	Marion, Polk, Yamhill, Washington, Columbia, Benton, Tillamook, Lane, Coos, Curry, Klamath, Wheeler and Malheur Counties	High river flows combined with high tide to flood some areas near the southern Oregon coast. Heavy rain combined with snow melt caused flooding along the Coquille River and the Rogue River twice this month in southwest Oregon. Heavy rain combined with snow melt caused flooding along the Sprague River in south central Oregon. Flows on the John Day River reached flood levels downstream of Monument due to the breaking up of an ice jam.	Riverine and coastal flooding
Oct. 2017	Tillamook, Benton and Clackamas Counties	A very potent atmospheric river brought strong winds to the north Oregon Coast and Coast Range on October 21. What followed was a tremendous amount of rain for some locations along the north Oregon Coast and in the Coast Range, with Lees Camp receiving upwards of 9 inches of rain. All this heavy rain brought the earliest significant Wilson River Flood on record, as well as flooding on several other rivers around the area.	Riverine
June 2018	Lane County	In Lane County an upper-level trough moved across the area from the southwest, generating strong thunderstorms which produced locally heavy rainfall, lightning, hail, and gusty winds.	
April 2019	Statewide	The event occurred April 6-21, 2019. Counties that were part of the disaster declaration: Linn, Douglas, Curry, Wheeler, Grant, and Umatilla. Individual and Public Assistance money was approved. (FEMA-4452-DR-Oregon)	Riverine, coastal, and urban flooding
Sept. 2020	Northwestern Oregon	An eastward-moving upper-level trough and associated area of surface low pressure moved across northwest Oregon and southwest Washington Sept. 17-18, resulting in widespread showers and thunderstorms. One severe thunderstorm developed southeast of Salem and moved northward across the eastern Willamette Valley and Cascade Foothills before 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. Other thunderstorms developed over southwest Washington producing heavy rainfall and local flooding.	Riverine and urban flooding

Date	Location	Characteristics	Type of Flood
Dec. 2020	Western Oregon	A series of strong Pacific fronts moved across the region bringing high winds to the coast with heavy rain across much of the area. The heavy rains resulted in flooding of some coastal rivers as well as small stream flooding and a debris flow.	Riverine and coastal flooding
Jan. 2021	Willamette Basin	A series of slow-moving fronts brought periods of heavy rain along with strong winds. This resulted in high surf; coastal, river and urban flooding; landslides; and debris flows. As the front moved inland early on the Jan. 13, a debris flow resulted in a fatality in the Columbia River Gorge. The front brought a burst of 35-50 mph winds to the Willamette Valley and southwest Washington interior resulting in over 100K customers without power across southwest Washington and northwest Oregon.	Riverine, coastal, and urban flooding

Source: Taylor et al., 1999; National Oceanic and Atmospheric Administration.

Future Climate Variability

According to the *Fifth Oregon Climate Assessment* (2021), flood magnitudes are likely to increase in Oregon. It is very likely (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (high confidence), which is also driven by antecedent conditions (soil moisture, water table height), snowmelt, river network morphology, and spatial variability in precipitation and snowmelt Moreover, heavy precipitation events are expected to become more intense because a warmer atmosphere can carry more moisture and the relatively contribution to floods of rainfall will be greater than that of snowmelt. The report continues by indicating that the wet season precipitation is projected to increase and thus winter flood magnitude will also likely increase. According to the 2020 Oregon NHMP for the Mid/Southern Willamette Valley (Region 3), along the Willamette River and its tributaries, the largest increases in extreme river flows are more likely to be upstream (toward the Cascade Range headwaters), and less likely downstream. Overall, it is more likely (>50%) that increases in extreme river flows will lead to an increase in the incidence and magnitude of damaging floods (low confidence), although this depends on local conditions (site-dependent river channel and floodplain hydraulics). Increases in extreme river flows leading to damaging floods will be less likely where storm water management (urban) and/or reservoir operations (river) have capacity to offset increases in flood peak.

The *Salem Climate Action Plan 2021*, includes numerous strategies to address a variety of climate-related challenges facing the city including flooding. The plan acknowledges significant projected climate impacts including the following:

- More intense rainfall and rain-on-snow events could also lead to flood events in areas outside of historical high-risk zones. *Department of State Lands, Wetlands Functions and Assessment* (May 2001)

Probability Assessment

The Federal Emergency Management Agency has mapped the 10, 50, 100, and 500-year floodplains in portions of Salem (see Figure 29 and Figure 30 and referenced 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.

Based on the available data and research for Salem the NHMP Steering Committee determined the **probability of experiencing a flood is "high,"** meaning one incident is likely within the next 10-year period.

Vulnerability Assessment

The extent of the damage and risk to people caused by flood events is primarily dependent on the depth and velocity of floodwaters. Fast moving floodwaters can wash buildings off their foundations and sweep vehicles downstream. Roads, bridges, lifelines (pipelines, utility, water, sewer, communications systems, etc.), and other infrastructure can be seriously damaged when high water combines with flood debris, mud and ice. Extensive flood damage to residences and other structures can result in basement flooding and landslide damage related to soil saturation. Surface water entering crawlspaces, basements, and daylight basements is common during flood events not only in or near flooded areas but also on hillsides and other areas far removed from floodplains. Most damage is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor coverings and appliances). If not properly protected from the entry of floodwaters, mechanical, electrical and similar equipment can also be damaged or destroyed by flooding. Economic damage from floods can be substantial.

Public Health

Protection of human life is of primary importance. This is paramount and is tied to several other community issues. Keeping homes safe from floodwaters will also help protect human life.

The Centers for Disease Control and Prevention warn that floodwaters pose a variety of health risks, including exposure to infectious diseases, chemical hazards, and injuries. Floodwaters can become contaminated with bacteria and hazardous chemicals which present the risk of disease through physical contact, ingestion, or open wounds. There is risk of physical injury from floating objects and damaged electrical power lines from floodwaters. The rapidly moving floodwaters also pose risk of drowning. Floodwaters can also cause indirect health risks. Animals can be displaced during flooding and give rise to a public health risk. Standing water during and after a flood can increase insect populations, creating additional risk of insect-borne diseases. If clean-up efforts are delayed after flood events, water-damaged buildings can collect mold, which is a significant health concern to building occupants. Many of these indirect public health concerns can be reduced after flood events by expediting repair of water-damaged buildings and other clean-up efforts.

When it comes to notifying the public in the event of a natural hazard event, through its *Emergency Management Plan*, Salem has put in place a preparedness team made up of various city departments including Fire, Police, Public Works, Community Development, Administrative Services, Human Resources, Information Technology, Emergency

Management, School District, and the Public Information Officer. Preparedness support also includes Marion and Polk Counties, various state and federal agencies, and local colleges, utilities, medical centers, transportation, and amateur radio emergency services. Dissemination of information to the public is done through Marion Polk Alert system for a variety of safety situations including evacuations, flooding, hazardous materials release, police activity requesting resident action. The Marion Polk Alert is managed by Marion and Polk Counties, in partnership with Salem's emergency personnel. In addition, information for the public is provided on City's website, Twitter, and Facebook. In very extreme cases, door-to-door notification to evacuate is used.

Floods in the past caused multiple major injuries or death. The potential for future injuries or deaths is anticipated to remain similar to historic events. It is estimated that 10-25% of the city's population would be physically displaced by a flood, accounting for the number of homes located in or near floodplains, and there would be moderate impact on community social networks.

Residential Building Damage

Homes in frequently flooded areas can experience blocked sewer lines and damage to septic systems and drainfields. This is particularly the case of residences in rural flood prone areas who commonly utilize private individual sewage treatment systems. Inundation of these systems can result in the leakage of wastewater into surrounding areas creating the risk of serious water pollution and public health threats. This kind of damage can render homes unlivable.

Many older manufactured home parks may be in floodplain areas. Manufactured homes have a lower level of structural stability compared to traditional lumber-built homes. Manufactured homes in floodplain zones should be anchored to provide additional structural stability during flood events.

Approximately 3,190 buildings are located within the City's regulatory floodplain, according to Salem's *Floodplain Management Plan* (2018). See Table 9 below regarding the zoning designation and number of structures in the regulatory floodplain. Those buildings zoned residential comprise approximately 70 percent of buildings in the floodplain. In addition to structural and life-safety impacts, flooding in residential areas can also result in the need for temporary shelters to house displaced residents.

The DOGAMI *Multi-hazard Risk Report for Marion County, Oregon* (Williamset al., 2022) indicates that there is the potential to have 2,932 (3.1% population) displaced residents and 1,588 damaged buildings during a 100-year flood scenario (1% annual chance). The loss estimate is $82,571,000 (loss ratio of 0.7%).

Development Change

Changes to development patterns have the potential to incur increased risk of flooding. However, city development regulations restrict, but do not prohibit, new development in areas identified as floodplain. This reduces the impact of flooding on future buildings. As new land has been brought into the Salem UGB the applicable development codes have been written to prevent the siting of new structures in flood prone areas.

Critical Facilities, Critical Infrastructure, and Vulnerable Population Centers

Of particular importance during flood events are critical facilities located in flood hazard areas. A critical facility is defined as a facility that needs to be operable during a flood, or for which even a slight chance of flooding might pose an unacceptable risk to health and safety. Critical facilities include schools, nursing homes, hospitals, police, fire, and other emergency responders, and installations that produce, use, or store hazardous materials. The Salem *Floodplain Management Plan* (2018) states,

> Fourteen critical facilities are located within the regulatory floodplain, totaling approximately $930 million in improvement value. Salem Hospital is a critical facility that can be substantially impacted during flood events, since vehicular access to the facility can be limited by street closures surrounding the hospital. Salem has also identified approximately 200 essential facilities (i.e., schools, residential care facilities, daycares, record retention facilities, hazardous waste storage, etc.) in the regulatory floodplain. City staff coordinates contact and flood response planning efforts with both critical and essential facilities. A critical and essential facilities database is maintained in the Salem Emergency Operations Center Situational Awareness Framework for Events (SAFE) system.
>
> In the January 2012 flood event, City public infrastructure damage was estimated at approximately $10 million. Most of the damage, $7.5 million, was to vehicular bridges; other damage included City-owned parks, buildings, streets, and water, wastewater, and stormwater facilities. The January 2012 event was somewhat localized to the Battle Creek and Mill Creek basins; however, the potential damage to critical facilities and infrastructure city-wide is significant.

The DOGAMI *Multi-hazard Risk Report for Marion County, Oregon* (Williams et al., 2022) indicates that during a 100-year flood scenario (1% annual chance), there is the potential to have 2,932 (3.1% population) displaced residents, 1,588 damaged buildings, 8 of which are critical facilities. The loss estimate is $82,571,000 (loss ratio of 0.7%).

The DOGAMI report for Marion County identifies the following eight critical facilities that are on property located entirely or partially in the floodplain.

1. Battle Creek Elementary (1640 Waln Drive SE)
2. North Salem High School (765 14th Street NE)
3. McNary Army Aviation Hangars (1921 Turner Road SE)
4. Salem Municipal Airport/McNary Field (2990 25th Street SE)
5. Oregon Dept of Transportation (various locations including 885 Airport Road SE)
6. Oregon State Police (3565 Trelstad Avenue SE)
7. Salem Hospital (890 Oak Street SE)
8. Salem Public Works (555 Liberty Street SE)

The DOGAMI report for Marion County also identified areas of significant risk. These locations are within the study area and are comparatively at greater risk from flood hazard. The following two are in or near Salem:

- The very large floodplain of Mill Creek (near Salem) and its tributaries from the city of Turner to Salem correspond to high levels of urban development. This area is at high risk from flood hazard.
- Buildings within the Willamette River floodplain, particularly in the city of Salem, including West Salem, are at risk from flood hazard.

Business and Industry

Flood events impact businesses by damaging property and by interrupting business. Flood events can cut off customer access to a business as well as close a business for repairs. The economic losses due to business closures often total more than the initial property losses that result from floods. Direct damages from flooding are the most common impacts, but indirect damages, such as diminished clientele, can be just as debilitating to a business. Floods can cut off customer vehicular and pedestrian access and close businesses for repairs. A quick response to the needs of businesses affected by flood events can help a community maintain economic viability in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.

Multiple facilities throughout the city anticipate severe damage due to a flood, estimated between $10 million and $100 million for hazard response, structural repairs and equipment replacement. In terms of commercial business, it is likely 10-30% of businesses located in the city and surrounding area would experience commerce interruption for a period of a months. Floods have the potential to inflict widespread damage to not only buildings but also the transportation network that may inhibit access to businesses. Lastly, floods would likely have extensive impacts on more than 75% of the city's ecological systems, including, clean water, wildlife habitat, and parks.

The Salem *Floodplain Management Plan* (2018) states the following regarding employers and economy,

> A number of employment centers are located within the regulatory floodplain. The Pringle Creek floodplain area includes industrial employment areas in the vicinity of McGilchrist Street SE and Salem Memorial Hospital, one of Salem's largest employers. Mill Creek can overflow into Salem Airport, which would potentially restrict air traffic, and the overflow can continue through industrial employment areas west of 25th Street SE, including the City Operations Complex. In West Salem, the Willamette River causes flooding in commercial areas along Wallace Road NW and Edgewater Street NW.
>
> Transportation impacts during flood events can cause significant economic impacts. Major transportation corridors can be closed by high water, restricting commercial traffic. The most significant transportation impacts involve the potential closure of arterial streets, including the Wallace/Edgewater intersection, Mission Street SE, Center Street NE/SE, State Street, and River Road S.

As noted previously, Salem's *Floodplain Management Plan* (2018) approximates 3,190 buildings that are located within the city's regulatory floodplain. Moreover, the DOGAMI *Multi-hazard Risk Report for Marion County, Oregon* (Williams et al., 2022) indicates that there is the potential to have 1,588 damaged buildings during a 100-year flood scenario (1% annual chance) with a loss estimate of $82,571,000 (loss ratio of 0.7%). Table 9 shows the number of structures in the floodplain by zoning designation.

Table 9 Number of Buildings in the Floodplain by Zoning Designation

Number of Buildings in the Floodplain by Zoning Designation	
Zoning Designation	**Number of Buildings**
Critical Facilities (All Zones)	14
Commercial	274
Industrial	364
Public	120
Residential	2,417
Mixed Use	1
TOTAL	**3,190**

Source: City of Salem, 2018

Public Infrastructure (General)

Publicly owned facilities are a key component of daily life for all residents of Salem. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services. Moreover, public buildings such as libraries, schools and government buildings are of concern to the city due to their potential utility in the event of a flood. These buildings can be used as temporary locations for medical and emergency housing services. Some public infrastructures noted here are provided in more detail below.

Roads

Road systems are important to the local economy, and during hazard events, resilient road connections are critical for providing essential and emergency services. Emergency vehicles can be delayed because of restricted mobility in flooded areas. Roads are maintained by multiple jurisdictions. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. Some roads in Salem cross floodplain areas.

Salem's *Floodplain Management Plan* (2018) identifies critical transportation corridors throughout Salem. Major streets that may likely be closed during flood events include those indicated in Table 10.

Table 10 Critical Transportation Corridors Affected by Flooding

Classification	Street Names
Parkway	Mission Street SE
Major Arterial	Center Street NE State Street Capitol Street NE/SE 12th Street NE/SE Hawthorne Avenue NE/SE Summer Street NE Madrona Avenue SE 25th Street SE McGilchrist Avenue SE River Road
Minor Arterial	17th Street NE/SE Airport Road SE Broadway Street NE Glen Creek Road NW Orchard Heights Road NW Fairview Industrial Drive SE Turner Road SE
Collector	Airway Drive SE Croisan Creek Road S D Street NE Fairway Avenue SE Oxford Street SE Hines Street SE 22nd Street NE/SE Rural Street SE Cross Street SE

Source: City of Salem, 2018

Bridges

Bridges are key points of concern during flood events for two primary reasons:

1. Bridges are often important links in road networks, crossing watercourses or other significant natural features.
2. Bridges can be obstructions in the floodway, collecting debris and inhibiting the flow of water during flood events. This can cause water to back up and inundate areas upstream from the bridge that would not otherwise be affected. Also, this build-up of water can suddenly release, causing a flash flood of larger magnitude downstream.

Wastewater Treatment Facility

Floods significantly impact drinking water and wastewater systems. When sewer systems are inundated with floodwaters, raw sewage can be flushed into the waterways, posing a significant health hazard. Additionally, drinking water supplies can be contaminated with flushed wastewater or high levels of solids (eroded soil for example), and made unsafe for consumption. Both water and sewage systems often require significant repair and maintenance work following a flood.

In Salem, wastewater is pumped to the Willow Lake Wastewater Pollution Control Facility, which is partially located within the floodplain. Because of this location, the facility is prone to some flooding. The City of Salem's wastewater system serves more than 60 square miles through over 800 miles of pipe and includes the cities of Turner and Keizer. When needed, the city has a back-up facility at River Road Park, which is not located in the floodplain. Once at Willow Lake Wastewater Pollution Control Facility, the wastewater is treated to clean it so that it is safe to be released to the Willamette River for downstream communities to re-use. According to Salem's Wastewater website, during the wet weather months or when there is a storm event expected that could overload the sanitary sewer system, crews carefully and continuously monitor the wastewater collection system, including 30 sewer pump stations around Salem, so releasing untreated wastewater into the Willamette River can be avoided.

Salem's Demonstration Project, also known as Natural Reclamation System, will determine whether technology should be used more extensively in the watershed. The demonstration project that uses the "natural systems as a sustainable method of improving water quality, provide reclaimed water supply and management, and to determine whether this technology is appropriate within the Willamette River watershed." For more information on this demonstration project, visit the following site: https://www.cityofsalem.net/community/household/water-utilities/wastewater/natural-reclamation-system-project.

Stormwater Systems

Stormwater systems collect and concentrate rainwater and rapidly deliver it into the local waterway. This infusion of water causes increased flows downstream. During large rainstorms and floods, these systems are pushed past their capacity and stormwater begins flowing over-ground, causing other infrastructure damage. Traditional stormwater systems are a benefit to urban areas by quickly removing captured rainwater, however, they can be detrimental to areas downstream.

Other problems often develop where open ditches enter culverts or go underground into stormwater systems. An obstruction at these intersections causes overland water flow. The filling of ditches and swales near buildings can inhibit or prevent the flow of water can compound these problems. Inadequate maintenance, especially following leaf accumulation in the fall, can also contribute to the flood hazard in urban areas.

Salem's stormwater system is considered by the state as separated from the wastewater treatment system. Salem provides its residents with a variety of stormwater services, including flooding response. The stormwater collection system that must be maintained consists of ditches, streams, pipe, detention basins, and storm drainage structures in and around the city. This system collects water to slow or divert the stormwater to areas where it can be filtered by natural environment or Salem's stormwater utility services and thus help keep excessive rain runoff and pollution from enter the local streams and rivers (City of Salem, *Stormwater*).

According to *Salem's Local Floodplain (Map)* website, the following streams are prone to flooding in the Salem area:

- Battle Creek
- Claggett Creek
- Croisan Creek
- Gibson Creek
- Glenn Creek
- Mill Creek
- Mill Race
- Powell Creek
- Pringle Creek
- Shelton Ditch

All water from this system will ultimately end up in the Willamette River. The higher the river, the more difficult it is for stormwater run-off to make it to the river. During significant rain events, the city typically experiences localized flooding first followed by river flooding after the rain event has passed. During heavy rains not necessarily associated with high river levels, sections of the storm system can become inundated and result in localized flooding. In general, these events do not cause damage to the City's storm water system and subside relatively quickly.

The City of Salem updated their *Stormwater Master Plan* in 2020. Under Policy 3.12, Flood Risks and Capital Project Criteria, the following risk reducing projects shall be considered in addition to increasing the capacity and construction of detention facilities:

> (1) Opportunity to retrofit structures, including elevating or relocating buildings, and applying of floodproofing techniques such as shields, membranes, waterproofing, venting, and other practices;
>
> (2) Evaluation of cost impacts based on damage assessment data contained in the Natural Hazard Mitigation Plan (City of Salem 2017);
>
> (3) Ability to implement green stormwater infrastructure to reduce runoff volumes and peak flows;
>
> (4) Ability to conduct floodplain and stream enhancement projects to increase flow attenuation and stream capacity; and (5) Suitability of purchasing flood-prone properties

Additional information on Salem's *Stormwater Master Plan* (2020) can be found at the following site:
https://www.cityofsalem.net/home/showpublisheddocument/5168/637798392359400000

Water Management and Water Quality

Floods significantly impact drinking water and long-term water quality monitoring is conducted by DEQ. Salem is located within the Willamette Basin. DEQ's North Santiam and South Santiam Subbasin Water Quality Overview indicates that bacteria, mercury, and temperature are significant concerns in this watershed. People can become sick if they ingest water that is contaminated with bacteria when they are swimming or otherwise in contact with the water. Both urban and rural/agricultural sources are major contributors to the high bacteria levels found in many of the rivers in the Willamette Basin. DEQ has set a goal to reduce bacterial loads by addressing direct discharges and runoff of bacterial sources. The Willamette River has fish consumption advisories due to elevated levels of mercury found in some fish species. The DEQ TMDL implementation program aims for a reduction in the load of total mercury from point sources and non-point erosion. Reductions in stream temperature can be achieved by reducing solar radiation loading by planting vegetation to increase streamside shading and by improving base flows.

As discussed in Salem's *Water Management and Conservation Plan* (WMCP), the city has a various means of obtaining drinking water including surface water, groundwater, and aquifer storage and recovery. Salem's primary water source is surface water from the North Santiam River. Water is diverted from the north channel of the river at approximately river mile 20 and is treated at the adjacent Geren Island Water Treatment Facility (Geren Island). Salem also holds water rights to appropriate water from the Willamette River.

Salem also appropriates and treats groundwater at Geren Island through a collector well facility. In addition, a limited amount of groundwater is available from wells within Salem's water service area. These groundwater sources are a supplemental during emergencies, water quality events, and peak demand periods.

Salem's Aquifer Storage and Recovery (ASR) system provides a supplemental water supply during periods of peak demand, high turbidity events, or emergencies. The city has four active ASR wells and may develop two more. With an ASR system, treated drinking water from the North Santiam River is injected into the Columbia River basalt aquifer via the ASR wells. The injected water is stored in the aquifer for later recovery.

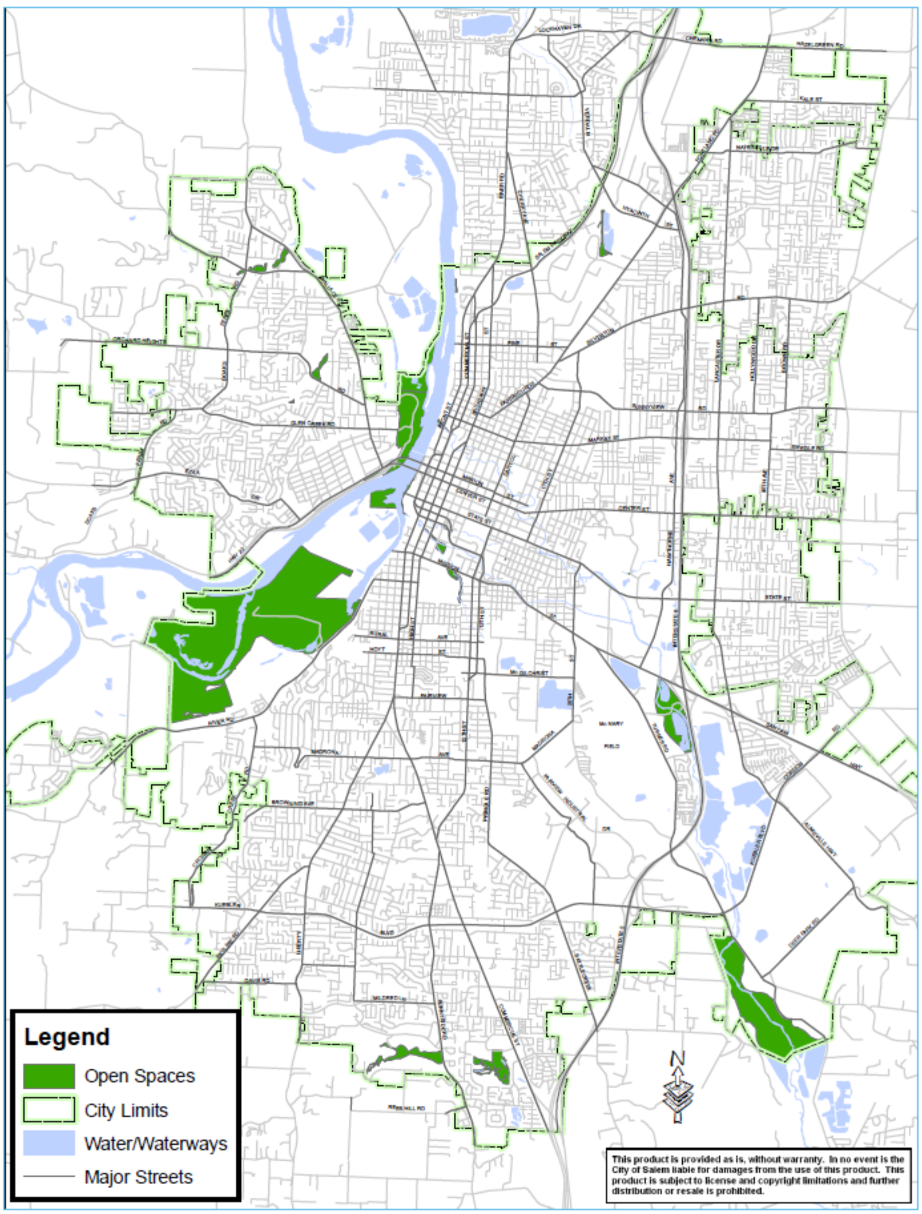
The City of Salem's WMCP describes the efforts to strengthen water supply reliability for its water customers. Salem recognizes that effective water management and conservation is critical. Included in this plan is a water curtailment plan that outlines proactive measures to reduce demand and to find alternative supplies during short-term water supply shortages. The intent is to minimize the impacts of water supply shortages, which may result from incidents including prolonged drought, mechanical or electrical equipment failure in the system, unanticipated catastrophic events (flooding, landslides, earthquakes and contamination), or events not under control of the water supplier.

Additional discussion regarding water management can be found under the Water Emergencies Hazard.

Parks, Open Space, and Natural Environments

The capacity of the natural environment is essential in sustaining all forms of life including human life, yet it often plays an underrepresented role in community resiliency to natural hazards such as floods. The natural environment includes land, air, water, and other natural resources that support and provide space to live, work and recreate. Natural capital 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 natural systems are impacted or depleted by human activities, those activities can adversely affect community resilience to natural hazard events.

Figure 31 Salem Open Spaces in Floodplain



Source: City of Salem, 2018

Public parks and publicly owned open space and natural systems can provide a buffer between flood hazards and private property. Maintaining and restoring natural systems helps mitigate the impact of flood events on the built environment. Flooding changes the natural environment and hydrology of an affected area. High water can be beneficial to the natural processes within a floodplain and can benefit riparian areas. Wetlands in public ownership can reduce flood impacts by absorbing floodwaters and buffering water level fluctuations.

Riparian areas are important transitional area that link water and land ecosystems. Vegetation in riparian areas is dependent upon stream processes such as flooding and often is composed of plants such as willow and cottonwood trees that require large amounts of water. Healthy vegetation in riparian buffers can reduce streamside erosion. During flood events, high water can cause significant erosion. Well-managed riparian areas can reduce the amount of erosion and help to protect water quality during flooding events.

Many floodplain and stream-associated wetlands absorb and store storm water flows, which reduces flood velocities and stream bank erosion. Preserving these wetlands reduces flood damage and the need for expensive flood control devices such as levees. According to Oregon Department of State Lands (DSL), when the storms are over, many wetlands augment summer stream flows by slowly releasing the stored water back to the stream system. Wetlands are highly effective at removing nitrogen, phosphorous, heavy metals, and other pollutants from water. For this reason, artificial wetlands are often constructed for cleaning storm water runoff and for tertiary treatment (polishing) of wastewater. Wetlands bordering streams and rivers and those that intercept runoff from fields and roads provide this valuable service free of charge.

According to Salem's *Comprehensive Park System Master Plan Update* (2013), there are approximately 1,928 acres of park land within the city; 1,328 acres are developed, and 600 acres are undeveloped. Parks in Salem range from the smallest neighborhood park, Gracemont Park (0.34 acres) to the expansive natural landscape of Minto-Brown Island Park. At 899 acres, Minto-Brown Island Park accounts for almost half of the city's total park acreage. Salem's parks include neighborhood, community and urban parks, linear parks, natural areas, historic areas and special use facilities. Salem's 600 acres of undeveloped park land include sites identified as neighborhood, community, and urban parks, and natural areas. These sites are dispersed throughout the city and range in size from less than an acre to over 50 acres. The natural areas that are primarily undeveloped lands left in a natural state for conservation are identified in Table 11.

Table 11 Natural Area Acreage, Salem, Oregon

Park	Developed Acres	Undeveloped Acres	Total Acres
Carson Springs	-	0.32	0.32
Chandler Nature Park	-	7.88	7.88
Claggett Creek Natural Area	-	41.87	41.87
Cunningham Lane	-	4.63	4.63
Eola Boaters Tract	-	2.00	2.00
Glen Creek Property	-	1.50	1.50
Minto-Brown Island Park	654.05	244.81	898.86
Mouth of Mill Creek	-	1.44	1.44
Skyline Natural Area[A]	-	35.26	35.26
Straub Nature Park	10.00	-	10.00
Wallace Natural Area[A]	-	57.66	57.66
Natural Area Total	**664.05**	**397.37**	**1,061.42**

[A] *Park classification changed since 1999 plan.*

Source: City of Salem, 2013

The *Comprehensive Park System Master Plan Update* states,

> These parks are designed to protect and manage unique or significant natural features, such as rivers, streams, wetlands, steep hillsides, environmentally sensitive areas, rare or endangered species, heritage trees, tree groves, forested areas, and wildlife habitat. Some natural areas may have limited access due to resource conservation needs. Natural areas provide a number of ecological benefits, including providing habitat, filtering stormwater, and controlling erosion. Protected sensitive areas should be the majority of the acreage in a natural area. Natural areas may support passive recreation, such as trail-related uses, bird and wildlife viewing, environmental interpretation and education, and nature photography. A developed natural area does not have the same high level of development or use as other park classes.

The Salem Area Comprehensive Plan is the primary guiding document for all planning and development efforts in the city, which includes a goal addressing acquisition and development of adequate parks and recreation facilities. It outlines several policies to guide Salem's park planning efforts that include park acquisition and development, priority acquisition, school and parks coordination, recreation, open space, heritage trees, and riparian areas. Policies related to parks and open spaces are also incorporated in numerous related sections, including stormwater, transportation, school location and development, Willamette River Greenway, scenic and historic areas, natural resources and hazards, and urban renewal. Some of Salem's waterway basin plans provide studies of natural areas. The Salem *Pringle Creek Basin Plan* (2019), provides the following analysis summary,

> Wetlands and Floodplains – Riparian areas, adjacent wetlands and local floodplains are important drainage features in a watershed because they decrease flood

volumes and rates of flow. Well-vegetated riparian areas may also store floodwaters, thereby reducing associated flood damage downstream. Furthermore, the natural capacity of a watershed to manage flood events is reduced when channelization occurs, impervious surfaces increase and wetlands are filled in.

For information on studies and analysis of natural areas incorporated into Salem's Stormwater Drainage Basin Plans, refer to the following:

Battle Creek Basin Plan, September 2019

Mill Creek Basin Plan, September 2019

Pringle Creek Basin Plan, September 2019

Power Supply

Flooding can also significantly impact electrical supply systems. Floodwaters short-out electrical lines and cause transformers to fail. Additionally, debris transported by floodwaters has the potential to knock down power poles and put live, high-voltage lines in the water, posing an electrocution hazard to people.

Communications/Phone Lines

Telephone and cable lines are similarly susceptible to floodwaters and floating debris. Underground lines are more resistant to flood damage, but often are exposed and damaged by swift currents.

Salem Climate Action Plan 2021

The *Salem Climate Action Plan 2021* outlines the following potential vulnerabilities and consequences of various projected climate changes as it relates to flooding.

Projected Precipitation Patterns

Though overall precipitation amounts are expected to remain consistent, increased temperatures noted above will lead to a water deficit. Precipitation patterns may change, leading to increased frequency of heavy downpour events and flooding.

- Flood conditions could be exacerbated in areas outside the historical high-risk floodplain and where new development is occurring. Risks to unsheltered people living near waterways could increase.
- Risk of water damage to homes and businesses from flooding.
- Water intrusion in homes can create mold issues, respiratory issues, and psychological stress.
- Potential harm to railroads, bridges, and overpasses from flooding.

As such, the NHMP Steering Committee rated the city as having a **"medium" vulnerability to flood hazards**, meaning that 1% to 10% of the city's population or property would be affected by a major flood event.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. There are numerous programs currently under way in Salem as well as Marion and Polk Counties that are designed to mitigate the impacts of flooding. These programs range from federally funded national programs to individual projects by landowners and projects by watershed councils and special districts. In addition to the information noted below, other activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

National Flood Insurance Program

The NFIP is a federal program administered by FEMA. The function of the NFIP is to provide flood insurance to homes and businesses located in floodplains at a reasonable cost, and to encourage the location of new development away from the floodplain. The program maps flood risk areas, and requires local implementation to reduce the risk, primarily through restricting new development in floodplains. The City of Salem participates in the National Flood Insurance Program.

Flood insurance covers only the improved land, or the actual building structure. It is important to note that property located outside the SFHA may still be subject to severe flooding. FEMA reports that 25% to 30% of all flood insurance claims are from owners of property located in low to moderate-risk areas located outside of the SFHA.

Repetitive Loss structures are defined as a NFIP-insured structure that has had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978. Repetitive Loss structures are concerning because they continue to expose lives and property to the flooding hazard. Local governments as well as the federal agencies, such as FEMA, attempt to address losses by encouraging and requiring floodplain insurance and funding projects such as acquiring land and improvements, relocating homes, or elevating structures. Continued repetitive loss claims from flood events lead to an increased amount of damage caused by floods, higher insurance rates, and contribute to the rising cost of taxpayer funded disaster relief for flood victims.

FEMA modernized the Salem Flood Insurance Rate Maps in January 2003. Table 12 shows that as of December 2022, Salem has 640 National Flood Insurance Program (NFIP) policies in force. The last Community Assistance Visit (CAV) for Salem was on March 22, 2017. Salem is a member of the Community Rating System (CRS) and has a Class 3 rating.

Table 12 Flood Insurance Detail

	City of Salem
Effective FIRM and FIS	1/2/2003
Initial FIRM Date	6/15/1979
Total Policies	640
Total Claims Since 1978	204
Insurance in Force	$185,240,100
Total Paid Claims Since 1978	$3,472,820
Substantial Damage Claims	6
Repetitive/Severe Repetitive Loss Properties	5
CRS Class Rating	3
Last Community Assistance Visit	3/22/2017

Source: Oregon Department of Land Conservation and Development; City of Salem,
Note: City of Salem resides in both Marion and Polk Counties. Depending on what part of the city, FIRM panels were issued January 19, 2000, January 2, 2003, or October 18, 2019.

Regarding "repetitive/severe repetitive loss" properties, as defined, Salem reports only five structures that have been identified by FEMA as repetitive loss. Salem is required to identify "repetitive loss areas" to protect the confidentiality of the repetitive loss structure and through that process identified approximately 50 structures that were potentially subject to the same flood as the repetitive loss structure(s) in that area. However, those 50 structures have not been identified as repetitive/severe repetitive loss properties and thus Salem reports only five. The five repetitive loss structures include one residential, two industrial and two commercial structures.

The City of Salem manages floodplain development through their local floodplain ordinance. The Development Services section within the Community Development Department is the city's lead work group that implements NFIP requirements and application of Salem Revised Code Chapter 601 – Floodplain Overlay Zone. The local floodplain ordinance is based on the State of Oregon model flood zone ordinance and is in compliance with the Code of Federal Regulations for the NFIP. The Development Services section maintains staff that are Certified Floodplain Managers (Robin Dalke, CFM, in 2023) and trained in both NFIP policies, federal, state and local floodplain regulations. Salem's Floodplain Administrator manages the floodplain management program, oversees annual recertifications with the Community Rating System Insurance Services Office (ISO) CRS Specialists and NFIP Community Assistance Visits with the Oregon Department of Land Conservation and Development NFIP Coordinator. A CFM with the City reviews all development activity in the Special Flood Hazard Area prior to issuance of applicable permits.

All projects within the Special Flood Hazard Area are reviewed by Salem's Certified Floodplain Manager for development permit requirements, including substantial improvement/damage of existing structures. Local officials determine if proposed work in a regulated SFHA or Interim Flood Hazard Area qualifies as a substantial improvement or repair of substantial damage as defined in SRC Chapter 601. The valuations for all projects are included in the initial development application and reviewed at submittal. For major improvements to existing structures, the applicant is notified that additional information is needed to determine substantial improvement/damage (SI/SD). In general, the project architect compiles the information needed to make the determination based on guidance in the FEMA Substantial Improvement/Substantial Damage Desk Reference, DLCD and FEMA support. If work on an existing structure constitutes substantial improvements or an existing structure is determined to be substantially damaged, then the existing structure must be brought into compliance with NFIP requirements for new construction. SRC Chapter 601 defines SI/SD as follows:

Substantial Improvement: Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the "start of construction" of the improvement. This term includes structures which have incurred "substantial damage", regardless of the actual repair work performed. The term does not, however, include either:

(a) Any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions; or
(b) Any alteration of a "historic structure," provided that the alteration will not preclude the structure's continued designation as a "historic structure."

Substantial Damage: Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

After a flood event, local building officials review flooded areas to determine areas that cannot be reoccupied and require a building permit for repairs. Based on the scope of repair work required, a substantial damage determination will be made in cooperation with the local officials responsible for reviewing floodplain development activity. Work on structures that are determined to be substantially damaged is considered to be substantial improvement regardless of the actual repair work performed.

Flood Insurance Rate Maps

The FIRM floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A FIRM is the official map produced by FEMA, which delineates special flood hazard areas or floodplains where NFIP regulations apply.

The City of Salem uses the FIRM to advise prospective homeowners of flood hazards, locate zoning boundaries that separate developable land from open space, make decisions for new development in floodplains, and administer the terms of the NFIP during the issuance of building permits. The maps are also used by insurance agents and mortgage lenders to determine if flood insurance is required.

City of Salem resides in both Marion and Polk Counties. Depending on what part of the city, FIRM panels were issued January 19, 2000, January 2, 2003, or October 18, 2019.

Flood Insurance Study

For mapped floodplain areas, the flood hazard data included in the Flood Insurance Study (FIS) allow quantitative calculation of the frequency and severity of flooding for any property within the floodplain. Such calculations are very important for mitigation planning because they allow the level of flood risk for any structure to be evaluated quantitatively.

Standard hydrologic and hydraulic study methods were used to determine the flood hazard data contained in the FIS. Flood events of a magnitude expected to occur once on average every 10-, 50-, 100-, and 500-year period were studied for each of Salem's rivers and creeks.

Quantitative flood hazard data are very important for mitigation planning purposes because they allow quantitative determination of the frequency and severity (i.e., depth) of flooding for any building or other facility (e.g., road or water treatment plant) for which elevation data exist. Such quantitative flood hazard data also facilitate detailed economic analysis (e.g., benefit-cost analysis) of mitigation projects to reduce the level of flood risk for a particular building or other facility.

Community Rating System

The NFIP CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. The CRS program recognizes a community's efforts to reduce flood risk, facilitate accurate insurance ratings, and promote the awareness of flood insurance.

For CRS communities, flood insurance premium rates are discounted in increments of 5%; i.e., a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount. Table 14 illustrates how the CRS point system is broken down.

Table 13 Summary of Points and Insurance Rate Discounts Under CRS

Credit Points	Class	Premium Reductions
0-499	10	0%
500-999	9	5%
1000-1499	8	10%
1500-1999	7	15%
2000-2499	6	20%
2500-2999	5	25%
3000-3499	4	30%
3500-3999	3	35%
4000-4599	2	40%
4500+	1	45%

Source: Federal Emergency Management Agency, 2022

Salem originally joined the CRS in 2008 and has continued to upgrade its rating through improvements to its floodplain management program. Some of the floodplain management and damage mitigation activities used by Salem include providing one-on-one advice to residents regarding property protection, implementing higher regulatory standards, maintaining open space, managing stormwater runoff, and developing a flood warning and response program. In late 2023, FEMA upgraded Salem from Class 4 to Class 3 CRS program. Unprecedented for any Oregon community, Salem is now ranked among the top one percent of over 1740 communities nationwide participating in the federal Community Rating System program.. Participation in the program acknowledges Salem's efforts that help save lives and reduce property damage in the event of a flood. Salem continues to make improvement in the CRS program and strives to improve the rating within any given year.

According to Salem's Flood Insurance website, the following are a few examples of Salem's involvement in credited activities include:

- Conduct outreach efforts to increase awareness of flood issues in Salem and provide information about protecting yourself, your family and your property from flooding;
- Maintain staff that are trained as Certified Floodplain Managers and able to assist the community with floodplain and flood insurance related inquiries;
- Improve flood map information and accessibility;
- Provide detailed review by floodplain management staff of all development proposals in the floodplain to ensure areas prone to flooding are not affected by the development activity;
- Require safe building practices to reduce future flood damage;
- Operate a drainage system maintenance program that includes annual inspections and regular maintenance of creeks, streams and ditches in Salem to reduce the risk of flooding; and
- Conduct flood response exercises and encourage community engagement in early warning and response efforts in the event of a flood.

Hazardous Materials Incident

Significant Changes Since Previous Plan:

There have not been significant changes to this hazard since the previous plan, however, this section has been reformatted.

Causes and Characteristics

For the purposes of mitigation planning, hazardous materials releases are considered a secondary hazard derived from the impact of a natural hazard event (i.e., flooding in a chemical storage area could result in toxic levels of chemicals in water or air). Hazardous materials may be defined simply as any materials that may have negative impacts on human health. That is, exposure to hazardous materials may result in injury, sickness, or death. They may also include materials that may cause negative impacts on the environment or on animal or plant species.

Hazardous chemicals are widely used in heavy industry, manufacturing, agriculture, mining, the oil and gas industry, forestry, and transportation as well as in medical facilities and commercial, public, and residential buildings. There are literally hundreds of thousands of chemicals that may be hazardous to human health, at least to some extent. A typical single-family home may contain dozens of potentially hazardous materials including fuels, paints, solvents, cleaning chemicals, pesticides, herbicides, medicines and others. However, for mitigation planning purposes, small quantities of slightly or moderately hazardous materials being used by end users are rarely the focus of interest. Rather, interest is focused primarily on larger quantities of hazardous materials in industrial use and on hazardous materials being transported, where the potential for accidental spills is high. Situations involving extremely hazardous materials or large quantities of hazardous materials in locations where accidents or malevolent actions (terrorism or sabotage) may result in significant public health risk are of special concern for planning purposes.

The severity of any hazardous material release incident for an affected community depends on several factors, including the toxicity, quantity, and dispersal characteristics of the hazardous material; local conditions such as wind direction, topography, soil and ground water characteristics; proximity to drinking water resources and populations.

There are three principal modes of human exposure to hazardous materials, **inhalation** of gaseous or particulate materials via the respiratory (breathing) process; **ingestion** of hazardous materials via contaminated food or water; and **direct contact** with skin or eyes.

Location and Extent

Hazardous materials incidents would likely be localized near the source of the incident, but major incidents could have extensive evacuation zones and affect a significant portion of Salem. The potential for casualties, including death and injury, is dependent on the location of incident, time of day, effectiveness of evacuation and materials involved.

The Office of State Fire Marshal maintains a hazardous materials database provided to city Fire Departments. The database includes information on chemicals stored by address with name, and phone number. Salem Environmental Services maintains a vast database (e.g., underground fuel tanks, waste generators, contaminated properties, etc.). These and other databases are linked to addresses of sites that use/generate hazardous materials/waste. The Salem Fire Department and Public Works have utilized the information in these databases and have a full-capacity hazmat response team to respond to hazardous materials incidents.

In Salem, specific places have higher than average risks for hazardous material releases. Trucking routes along I-5 and Highway 22 that run through Salem are vulnerable because of the quantity of materials transported along these routes. Also, the railroad lines that run through downtown Salem near the Capitol area are a concern because they carry significant quantities of hazardous materials transported through Salem each year. Figure 33 identifies important facilities and hazardous materials locations.

History

According to the Office of the State Fire Marshal *Community Right-to-Know (CR2K) Hazardous Substance Incident Search*, between 2013 and May 2017, there have been 102 (20 involving hazmat teams) reported hazardous materials incidents, most of which have been negligible. Gas leaks are reported as the most common type of hazardous materials incident reported in the city. Most incidents are reported as unintentional accidents, but there are a few incidents of intentional hazardous materials release and/or exposure, all of which were effectively, and safety managed.

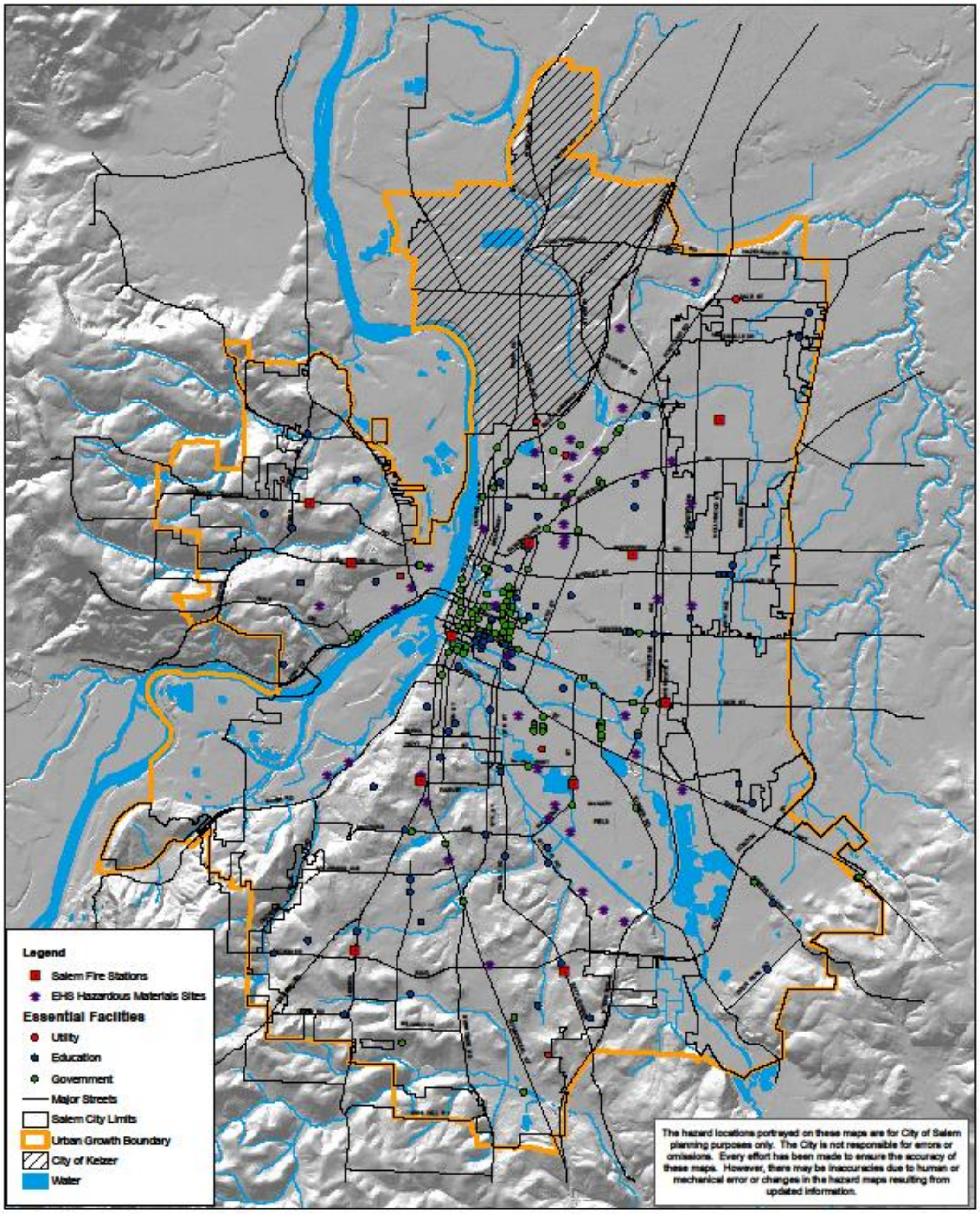
Future Climate Variability

Future climate variability does not affect the community's hazardous materials incident risk.

Probability Assessment

Based on the available data and research for Salem the NHMP Steering Committee determined the **probability of experiencing a hazardous materials event is "moderate,"** meaning one incident is likely within the next 35-to-75-year period; this rating has not changed since the previous plan.

Figure 32 Important Facilities and Hazardous Materials Locations



Source: City of Salem

Vulnerability Assessment

Hazardous materials events in the past caused multiple minor injuries or a major injury impacting the health and safety of residents. However, the potential for injuries or deaths from past events or from similar events in other communities could escalate resulting in multiple deaths and major injuries. It is estimated that less than 10% of the city's population would be physically displaced by a hazardous materials incident, likely the result of a minor spill or leak, and there would be mild impact on community social networks.

Facilities throughout the city are anticipated to reflect minor damage to several facilities due to hazardous materials, estimated between $1 million to $10 million for hazard response, structural repairs and equipment replacement. In terms of commercial business, it is likely 10-30% of businesses located in the city and surrounding area would experience commerce interruption for a period of at least a few days. Hazardous materials can be extremely dangerous, and businesses will be forced to closed if they are within the incident impact radius. Lastly, extreme heat would likely have extensive impacts on more than 75% of the city's ecological systems, including, clean water, wildlife habitat, and parks.

Many facilities throughout the city hold and store hazardous materials, the areas surrounding these facilities and the adjacent transport network that carry the substances are especially vulnerable. As such, the NHMP Steering Committee rated the city as having a **"high" vulnerability to hazardous materials hazards**, meaning that more than 10% of the city's population or assets would be affected by a major disaster; this rating has not changed since the previous plan.

Landslide

Significant Changes Since Previous Plan:

The Landslide Hazard section was reformatted and expanded with additional information since the previous plan.

Causes and 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.

Natural conditions and human activities can both play a role in causing landslides. Certain geologic formations are more susceptible to landslides than others. The incidence of landslides and their impact on people and property can be accelerated by development. 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.
- Natural conditions and processes including the geology of the site, rainfall, rapid snow melt, freeze/thaw cycles, wave and water action, and volcanic activity.

According to DOGAMI's *Landslide Hazards in Oregon* (2008), the following are other factors – natural or human-caused – that affect or increase the likelihood of landslides:

- Excavation and grading on sloping ground for homes, roads and other structures.
- Drainage and groundwater alterations that are natural or human-caused can trigger landslides. Human activities that may cause slides include broken or leaking water or sewer lines, water retention facilities, irrigation and stream alterations, ineffective stormwater management and excess runoff due to increased impervious surfaces.
- Any combination of these factors.

Types of Landslides

Slides

Slides move in contact with the underlying surface. These movements include rotational slides where sliding material moves along a curved surface and translational slides where movement occurs along a flat surface. These slides are generally slow moving and can be deep. Slow-moving landslides can occur on relatively gentle slopes and can cause significant property damage but are far less likely to result in serious injuries than rapidly moving landslides, according to the 2020 Oregon NHMP.

Topples and Falls

Rock falls occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations, such as those along highways, can cause falls where the road has been cut through bedrock. They are fast moving with the materials free falling or bouncing down the slope.

In falls, material is detached from a steep slope or cliff. The volume of material involved is generally small, but large boulders or blocks of rock can cause significant damage. Rock falls have the potential to break off power poles located on hillsides (Eichorn, 2004).

Spreads

Spreads are an extension and subsidence of commonly cohesive materials overlying layers. They are commonly triggered by earthquakes. Spreads usually occur on gentle slopes near open bodies of water, according to DOGAMI's *Landslide Hazards in Oregon* (2008).

Flows

Flows are plastic or liquid movements in which land mass (e.g., soil and rock) breaks up and flows during movement. Earthquakes often trigger flows (Robert Olson Associates, 1999). Flows can be either channelized and unchannelized and may also be called debris avalanches and earth flows. Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring soils from the slope along its path. Flows are typically rapidly moving and tend to increase in volume as they scour out the channel (Robert Olson Associates, 1999). Flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances.

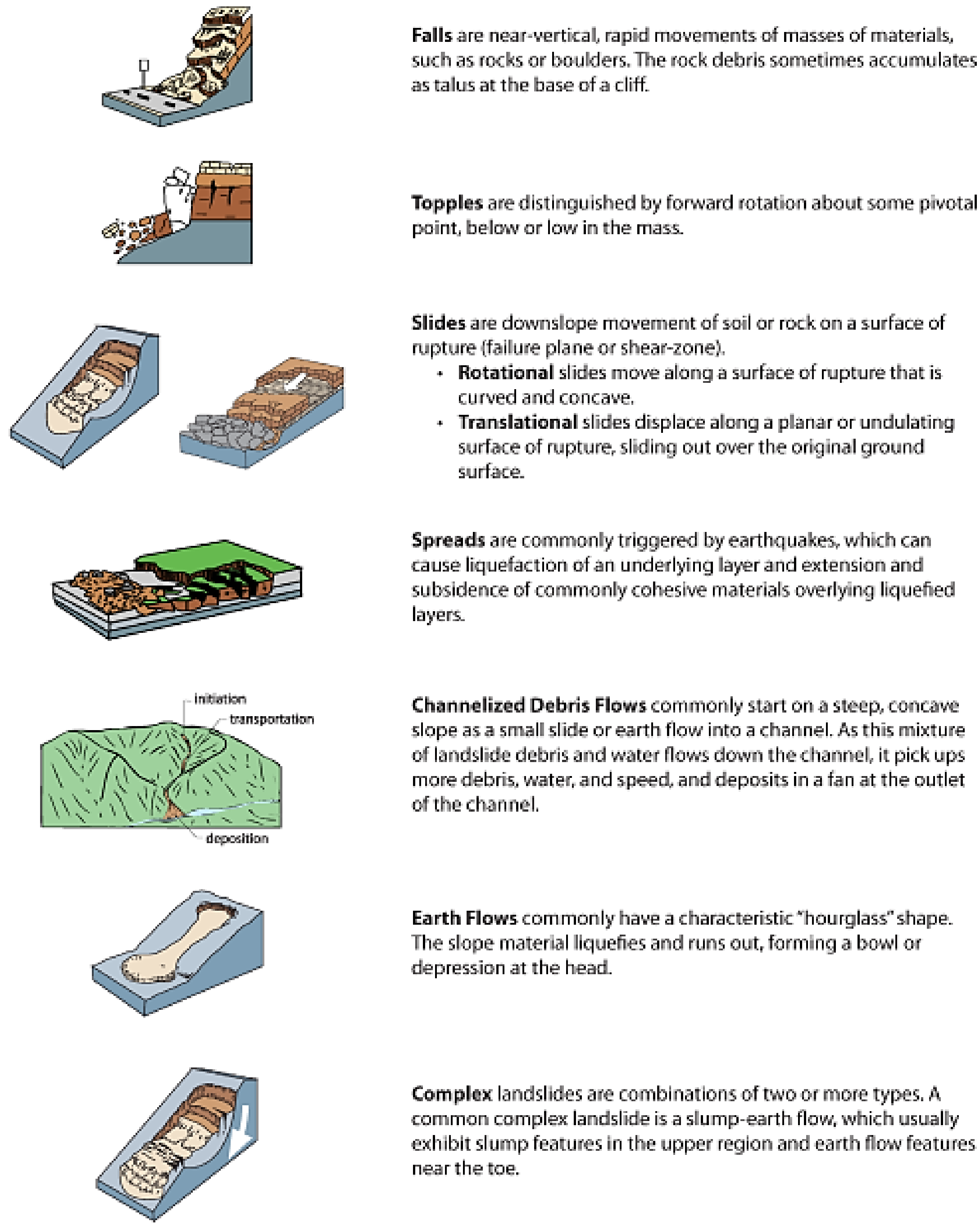
The channelized debris flow, which is sometimes referred to as "rapidly moving landslide" can be life threatening. They often initiate on a steep slope, move into a steep channel (or drainage), increase in volume by incorporating channel materials, and then deposit material, usually at the mouth of the channel on existing fans. Debris flows are commonly mobilized by other types of landslides that occur on slopes near a channel.

Over time, ditches and culverts beneath hillside roads can become blocked with debris. If the ditches are blocked, run-off from the slopes is inhibited during periods of precipitation. This causes the run-off water to collect in soil, and in some cases, cause a slide. Usually the slides are small (100 – 1,000 cubic yards), but the flow can be quite large.

Complex

Complex landslides are the combinations of two or more types. A common complex landslide is a slump-earth flow, which usually exhibits slump features in the upper region and earth flow features near the toe (Burns & Madin, 2009).

Figure 33 Types of Common Landslides in Oregon



Source: Burns, et al., 2019

Location and Extent

The characteristics of the minerals and soils present in Salem indicate the potential types of hazards that may occur. Rock hardness and soil characteristics can determine whether an area will be prone to geologic hazards such as landslides.

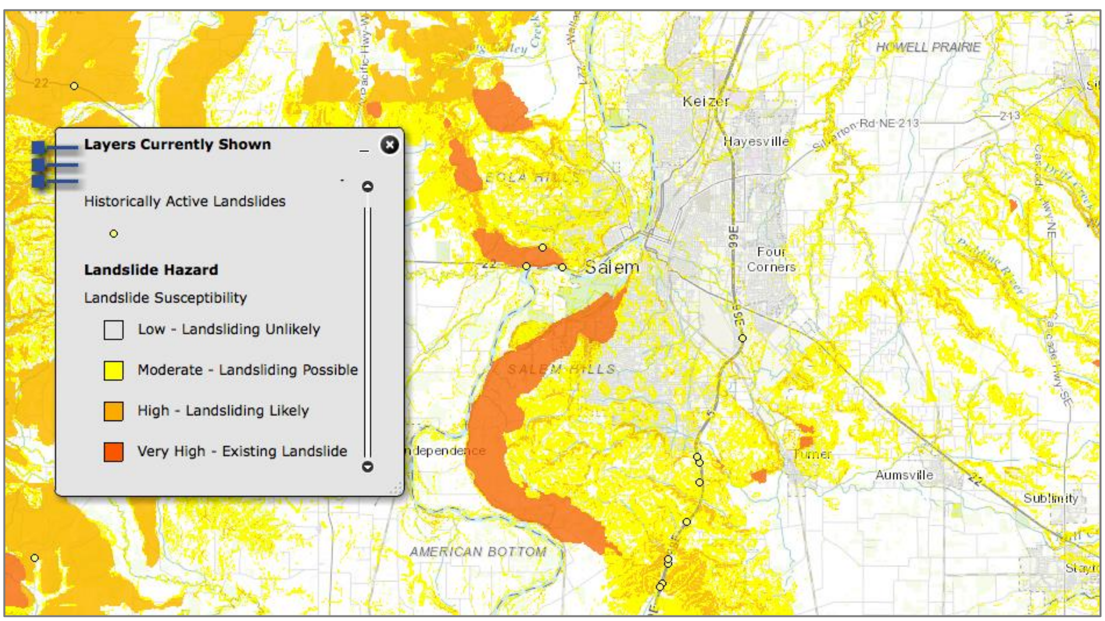
In general, areas at risk to landslides have steep slopes (25 percent or greater,) or a history of nearby landslides. In otherwise gently sloped areas, landslides can occur along steep river and creek banks, and along ocean bluff faces. At natural slopes under 30 percent, most landslide hazards are related to excavation and drainage practices, or the reactivation of preexisting landslide hazards. The severity or extent of landslides is typically a function of geology and the landslide triggering mechanism. Rainfall initiated landslides tend to be smaller, and earthquake induced landslides may be very large. Even small slides can cause property damage, result in injuries, or take lives.

Natural conditions and human activities can both play a role in causing landslides. The incidence of landslides and their impact on people and property can be accelerated by development.

Landslides and debris flows are possible in any of the higher slope portions of Salem, including much of the western portion of the city (see Figure 35).

DOGAMI's *Multi-Hazard Risk Report for Marion County, Oregon* (Williams et al., 2022), which includes Salem, acknowledges that most of the land in the county is located on gentle terrain, which is typically low susceptibility landslide zones. However, the report states areas of greater risk to landslide hazard include, "The residential neighborhoods in the southwestern portions of Salem and just outside of Salem (mapped as Very High susceptibility)."

Figure 34 Landslide Susceptibility Exposure



Source: Oregon Department of Geology and Mineral Industries, SLIDO

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.

Table 14 shows landslide susceptibility exposure for Salem. Approximately 7% of the city land has High or Very High landslide susceptibility exposure. Note that even if a 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 14 Landslide Susceptibility Exposure

Jurisdiction	Area, ft^2	Low	Moderate	High	Very High
Salem	1,368,874,853	69.3%	23.3%	3.5%	3.9%

Source: Burns, et al., 2016

The severity or extent of landslides is typically a function of geology and the landslide triggering mechanism. Rainfall initiated landslides tend to be smaller, and earthquake induced landslides may be very large. Even small slides can cause property damage, result in injuries, or take lives.

For more information, refer to the following reports:

Open-File Report: O-2016-02, Landslide Susceptibility Overview Map of Oregon

Open-File Report: O-2010-03, Digital geologic map of the southern Willamette Valley, Benton, Lane, Linn, Marion, and Polk Counties, Oregon

Open-File Report: O-2020-12, Landslide inventory for a portion of Marion County, Oregon

Open-File Report O-2021-14, Landslide, coseismic liquefaction susceptibility, and coseismic soil amplification class maps, Benton, Marion, Morrow, And Washington Counties, Oregon

Special Paper 34: Slope failures in Oregon: GIS inventory for three 1996/97 storm events, 2000

Additional reports are available via DOGAMI's Publications Center website: https://www.oregongeology.org/pubs/

Identifying Landslides

Landslides are very difficult to predict. Landslides are downhill or lateral movements of rock, debris, or soil mass. Landslides vary greatly in the volumes of rock and soil involved, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names depending on the type of failure and their composition and characteristics. According to DOGAMI's *Landslides Hazards in Oregon*, all landslides can be classified into six types of movement: 1) slides, 2) topples, 3) falls, 4) spreads, 5) flows, and 6) complex, which are described above.

Although the factors determining what type of movement will manifest for any given landslide are very complex, the topographic nature of the slope and the type of slope material often play dominant roles. 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 and potential mitigation alternatives. Movement type should be combined with other landslide characteristics such as type of material, rate of movement, depth of failure, and water content to understand the landslide behavior more fully. It is common for failures to reoccur where previous ones happened; this is true for all types of landslide movements and over periods much longer than human recorded history.

In addition, landslides may be broken down into the following two categories: (1) rapidly moving; and (2) slow moving. Rapidly moving landslides are typically “off-site” (debris flows and earth flows) and present the greatest risk to human life, and persons living in or traveling through areas prone to rapidly moving landslides are at increased risk of serious injury. Rapidly moving landslides have also caused most of the recent landslide-related injuries and deaths in Oregon. Slow moving landslides tend to be “on-site” (slumps, earthflows, and block slides) and can cause significant property damage but are less likely to result in serious human injuries.

For a more complete description of the different types of landslides, see U.S. Transportation Research Board *Landslides: Investigation and Mitigation, Special Report 247* (Turner & Schuster, 1996), which has an extensive chapter on landslide types and processes.

Regarding identifying applicable conditions that may trigger a landslide or debris flow event, a notice starts with the National Weather Service. The NWS uses unique language in their flood watch products. Once this information is received, Oregon DOGAMI posts on their website an alert message including a link to the NWS notice and they send out a press release to affected areas. Oregon Department of Emergency Management broadcasts the alert message and ODOT will turn on highway warning signs at appropriate locations and post on the TripCheck website (https://tripcheck.com/).

History

Landslides are a chronic problem in Oregon, affecting both infrastructure and private property. Approximately 13,048 documented landslides have occurred in Oregon in the last 150 years. The combination of geology, precipitation, topography, and seismic activity makes portions of Oregon especially prone to landslides (Burns et al., 2019).

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., 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 Salem. 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.

In February 1996, November 1996, and December 1996/January 1997 the Willamette Valley experienced heavy rainfall and snowmelt which led to widespread landslide events throughout the state. Disaster declarations were issued for Marion County for the February 1996 and December 1996/January 1997 storms (Governor Executive Orders EO-96-12, EO-97-9). During these storms, many landslides occurred in the eastern portion of the state and are too numerous to list here. In 2000, DOGAMI mapped the historical instances of landslide events throughout the Willamette Valley for the 1996-1997 storms, including Salem (Harvey & Peterson, 1998). Landslides also occurred with heavy rain events in January 2012 (FEMA-4055-DR-OR), February 2014 (FEMA-4169-DR-OR), and December 2015 (FEMA-4258-DR-OR).

The geologic setting of the Salem Hills illustrates a historic pattern of landslides. Many prominent features that help identify the ancient landslide terrain are hummocky topography, disrupted drainage patterns, sag ponds, springs, back-tilted bedrock blocks, and subdued head scarps. In 2005, a landslide blocked traffic to the Salem along South River Road, near South Owen Street. The 2005 Slide did not damage any homes. Another landslide occurred in January of 2011 on South River Road between Owens Street and Croissan Creek. The slide brought down a boulder that blocked thoroughfare.

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

Future Climate Variability

According to the Marion County Future Projections Report, the climate risk primarily associated with landslides is heavy rain and its related metrics as landslides may result from the increased weight of soils saturated with water. “There is greater uncertainty in projections of future precipitation than projections of future temperature. Precipitation has high natural variability, and the atmospheric patterns that influence precipitation are represented differently among global climate models.” While “by the 2050s under the higher emissions scenario, the average number of days per year in Marion County on which the landslide risk threshold is exceeded is projected to remain about the same, with a change of -0.2 days,” landslide risk depends on multiple site-specific factors and this metric does not reflect all aspects of the hazard (Dalton et al., 2022).

“Landslide risk also can become high when heavy precipitation falls on an area that burned within approximately the past five to ten years. By the year 2100, under the higher emissions scenario, the probability that an extreme rainfall event will occur within one year after an extreme fire-weather event in Oregon or Washington was projected to increase by 700% relative to 1980–2005 (Touma et al., 2022).” (Dalton et al., 2022)

Probability Assessment

The probability of rapidly moving landslides occurring depends on several factors; these include steepness of slope, slope materials, local geology, vegetative cover, human activity, and water. There is a strong correlation between intensive winter rainstorms and the occurrence of rapidly moving landslides (debris flows). The Oregon Department of Forestry (ODF) tracks storms during the rainy season, monitors rain gauges and snow melt, and issues warnings as conditions warrant. Other agencies such as ODOT, DOGAMI, USGS, and National Weather Service also track weather conditions and potential landslide situations.

Based on the available data and research for Salem the NHMP Steering Committee determined the **probability of experiencing a landslide is "high,"** meaning at least one incident is likely within the next 35-year period.

Vulnerability Assessment

Landslides are very difficult to predict. Vulnerability assessments assist in predicting how different types of property and population groups will be affected by a hazard. The optimum method for doing this analysis at the city or county level is to use parcel-specific assessment data on land use and structures. Data that includes specific landslide-prone and debris flow locations in the county can be used to assess the population and total value of property at risk from future landslide occurrences.

Landslides can occur on their own or in conjunction with other hazards, such as flash flooding. Depending upon the type, location, severity and area affected, severe property damage, injuries and loss of life can be caused by landslide hazards. Landslides can damage or temporarily disrupt utility services, block off or damage roads, critical lifeline services such as police, fire, medical, utility and communication systems, and emergency response. Communities may suffer immediate damages 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 all 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 Salem residents are dependent on roads and bridges for travel to work, delays and detours are likely to have an economic impact on city 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.

Lifelines and critical facilities should remain accessible if possible, during a natural hazard event. The impact of closed transportation arteries 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.

A quantitative landslide hazard assessment requires overlay of landslide hazards (frequency and severity of landslides) with the inventory exposed to the hazard (value and vulnerability) by considering:

1. Extent of landslide susceptible areas;
2. Inventory of buildings and infrastructure in landslide susceptible areas;
3. Severity of earthquakes or winter storm event (inches of rainfall in 24 hours);
4. Percentage of landslide susceptible areas that will move and the range of movements (displacements) likely; and

5. Vulnerability (amount of damage for various ranges of movement).

Currently, data does not allow for specific estimates of life and property losses during a given scenario.

Landslides in the past caused few minor injuries. However, the potential for injuries or deaths from past events or from similar events in other communities could escalate resulting in multiple minor injuries and a possible major injury. Salem estimates that less than 10% of the city's population could be physically displaced by a landslide, considering landslide events tend to have localized impacts; and there would be little to no impact on community social networks. As noted above and in the *Multi-Hazard Risk Report for Marion County, Oregon* report, it states that areas of greater risk to landslide hazard in the city include, "The residential neighborhoods in the southwestern portions of Salem and just outside of Salem (mapped as Very High susceptibility)" (Williams et al., 2022).

Multiple facilities throughout the city anticipate moderate damage due to a landslide, estimated at less than $1 million for hazard response, structural repairs and equipment replacement. In terms of commercial business, it is likely that less than 10% of businesses located in the city and surrounding area could experience commerce interruption for a period of days. Landslide hazards have the potential to affect transportation and may inhibit access to businesses until roadways can be cleared. Lastly, landslides would likely have mild impacts on 10-25% of the City's ecological systems, including, clean water, wildlife habitat, and parks.

According to DOGAMI's *Multi-hazard Risk Report for Marion County, Oregon* (Williams et al., 2022), during a high and very high susceptibility landslide scenario, there is the potential to have 12,356 displaced residents, 4,031 exposed buildings, 1 of which is a critical facility. Exposed building value of $1,378,070,000 (exposure ratio 9.3%).

As such, the NHMP Steering Committee rated the city as having a **"low" vulnerability to landslide hazards**, meaning that less than 1% of the city's population or assets would be affected by a major disaster.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

Volcano

> **Significant Changes Since Previous Plan:**
>
> The Volcano Hazard section was reformatted and expanded with additional information since the previous plan.

Causes and Characteristics

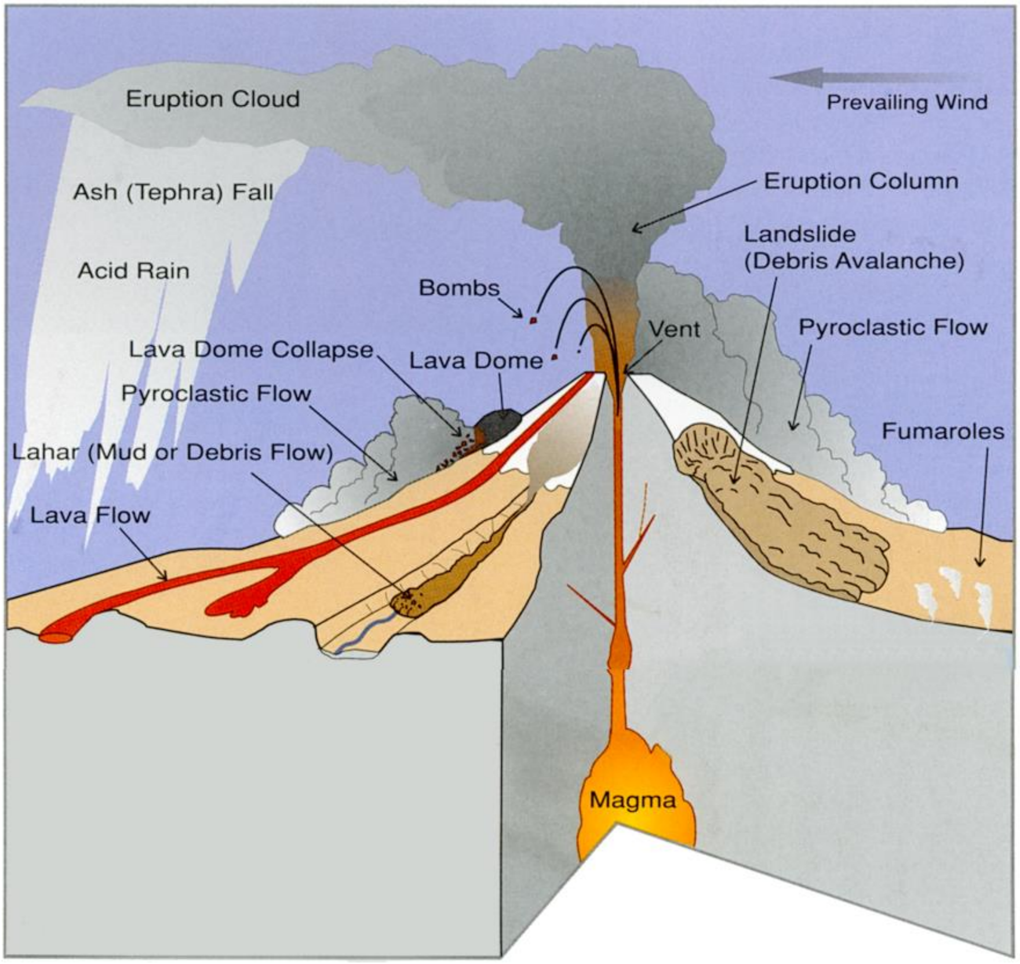
The City of Salem and the Pacific Northwest, lie within the "ring of fire," an area of very active volcanic activity surrounding the Pacific Basin. Volcanic eruptions occur regularly along the ring of fire, in part because of the movement of the Earth's tectonic plates. The Earth's outermost shell, the 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. The following section outlines the specific hazards posed by volcanoes.

According to the USGS General Interest Publication, *Volcanoes* (Tillings, 1999), volcanoes are commonly conical hills or mountains built around a vent that connect with reservoirs of molten rock below the surface of the earth. Some younger volcanoes may connect directly with reservoirs of molten rock, while most volcanoes connect to empty chambers. Unlike most mountains, which are pushed up from below, volcanoes are built up by an accumulation of their own eruptive products: lava or ash flows and airborne ash and dust. When pressure from gases or molten rock becomes strong enough to cause an upsurge, eruptions occur. Gases and rocks are pushed through the opening and spill over or fill the air with lava fragments. Figure 35 diagrams the basic features of a volcano.

Volcanic eruptions often involve several distinct types of hazards to people and property, as well evidenced by the Mount St. Helens eruption. Major volcanic hazards include eruption columns and clouds, volcanic gases, lava flows and domes, pyroclastic flows, volcanic landslides, and lahars, which are described below. Some of these hazards (e.g., lava flows) only affect areas very near the volcano. Other hazards may affect areas 10 to 20 miles away from the volcano, while ash falls may affect areas many miles downwind of the eruption site.

Figure 35 Volcanic Hazard from a Composite Type Volcano



Source: Walder, et al., 2000

Characteristics of Volcanoes

Eruption Columns and Clouds

An explosive eruption blasts solid and molten rock fragments called tephra and volcanic gases into the air with tremendous force. The largest rock fragments, called bombs, usually fall back to the ground within two miles of the vent. Small fragments (less than 0.1 inch across) of volcanic glass, mineral and rock (ash) rise high into the air forming a huge, billowing eruption column. Eruption columns creating an eruption cloud can grow rapidly and reach more than 12 miles above a volcano in less than 30 minutes. Volcanic ash clouds can pose serious hazards to aviation. Several commercial jets have nearly crashed because of engine failure from inadvertently flying into ash clouds.

Large eruption clouds can extend hundreds of miles downwind resulting in ash fall over enormous areas. Ash from the May 18, 1980 Mt. St. Helens eruption fell over an area of 22,000 square miles in the western U.S. Heavy ash fall, particularly when mixed with rain, can collapse buildings and even a minor ash fall can damage crops, electronics, and machinery.

Ash/Tephra

Tephra consists of volcanic ash (sand-sized or finer particles of volcanic rock) and larger fragments. During explosive eruptions, tephra together with a mixture of hot volcanic gas are ejected rapidly into the air from volcanic vents. Larger fragments fall near the volcanic vent while finer particles drift downwind as a large cloud. When ash particles fall to the ground, they can form a blanket-like deposit, with finer grains carried further away from the volcano. In general, the thickness of ash fall deposits decreases in the downwind direction. Tephra hazards include impact of falling fragments, suspension of abrasive fine particles in the air and water, and burial of structures, transportation routes and vegetation.

According to the *2020 Oregon Natural Hazard Mitigation Plan*, during an eruption that emits ash, the ash fall deposition is controlled by the prevailing wind direction. The predominant wind pattern over the Cascades is from the west, and previous eruptions seen in the geologic record have resulted in most ash fall drifting to the east of the volcanoes.

Volcanic Gases

Volcanoes emit gases during eruptions. Even when a volcano is not erupting, cracks in the ground allow gases to reach the surface through small openings called fumaroles. More than 90 percent of all gas emitted by volcanoes is water vapor (steam), most of which is heated ground water. Other common volcanic gases are carbon dioxide, sulfur dioxide, hydrogen sulfide, hydrogen and fluorine. In higher concentrations, these gases can cause corrosion, contaminate domestic water supplies and harm or even kill vegetation, livestock, and people.

Lava Flows and Domes

Lava flows are streams of molten rock that erupt relatively non-explosively from a volcano and move downslope, causing extensive damage or destruction by burning, crushing, or burying everything in their paths. Secondary effects can include forest fires, flooding, and permanent reconfiguration of stream channels, according to the 2020 Oregon NHMP.

Pyroclastic Flows and Surges

Pyroclastic flows are avalanches of rock and gas at temperatures of 600 to 1500 degrees Fahrenheit. They typically sweep down the flanks of volcanoes at speeds of up to 150 miles per hour. Pyroclastic surges are a more dilute mixture of gas and rock. They can move even more rapidly than a pyroclastic flow and are more mobile. Both generally follow valleys but surges sometimes have enough momentum to overtop hills or ridges in their paths. Because of their high speed, pyroclastic flows and surges are difficult or impossible to escape. If it is expected that they will occur, evacuation orders should be issued as soon as possible for the hazardous areas. Objects and structures in the path of a pyroclastic flow are generally destroyed or swept away by the impact of debris or by accompanying hurricane-force winds. Wood and other combustible materials are commonly burned. People and animals may also be burned or killed by inhaling hot ash and gases. The deposit that results from pyroclastic flows is a combination of rock bombs and ash and is termed *ignimbrite.* These deposits may accumulate to hundreds of feet thick and can harden to resistant rock. The climactic eruption of Mount St. Helens generated a series of explosions that formed a huge pyroclastic surge which destroyed an area of 230 square miles and leveled trees six feet in diameter as far as 15 miles from the volcano.

Volcanic Landslides/Debris Avalanches

Volcanic eruptions can be triggered by seismic activity or earthquakes can occur during or after a volcanic eruption. Earthquakes produced by stress changes are called volcano-tectonic earthquakes. These earthquakes, typically small to moderate in magnitude, occur as rock is moving to fill in spaces where magma is no longer present and can cause land to subside or produce large ground cracks (Riley). In addition to being generated after an eruption and magma withdrawal, these earthquakes also occur as magma is intruding upward into a volcano, opening cracks and pressurizing systems (Scott, 2001). Volcano-tectonic earthquakes do not indicate that the volcano will be erupting but can occur at any time and cause damage to manmade structures or provoke landslides. (Wright & Pierson, 1992)

Lahars and Debris Flows

Lahar is an Indonesian term that describes a hot or cold mixture of water and rock fragments flowing down the slopes of a volcano or river valley, according to the USGS Cascades Volcano Observatory. Lahars typically begin when floods related to volcanism are produced by melting snow and ice during eruptions of ice-clad volcanoes like Mount Shasta, and by heavy rains that may accompany eruptions. Floods can also be generated by eruption-caused waves that could overtop dams or move down outlet streams from lakes.

Lahars react much like flash flood events in that a rapidly moving mass moves downstream, picking up more sediment and debris as it scours out a channel. This initial flow can also incorporate water from rivers, melting snow and ice. By eroding rock debris and incorporating additional water, lahars can easily grow to more than ten times their initial size. But as a lahar moves farther away from a volcano, according to USGS Cascades Volcano Observatory, it will eventually begin to lose its heavy load of sediment and decrease in size.

Lahars often cause serious economic and environmental damage. According to USGS, the direct impact of a lahar’s turbulent flow front or from the boulders and logs carried by the lahar can easily crush, abrade, or shear off at ground level just about anything in the path of a lahar. Even if not crushed or carried away by the force of a lahar, buildings and valuable land may become partially or completely buried by one or more cement-like layers of rock debris. By destroying bridges and key roads, lahars can also trap people in areas vulnerable to other hazardous volcanic activity, especially if the lahars leave deposits that are too deep, too soft, or too hot to cross.

Earthquakes

Volcanic eruptions can be triggered by seismic activity or earthquakes can occur during or after a volcanic eruption. Earthquakes produced by stress changes are called volcano-tectonic earthquakes. These earthquakes, typically small to moderate in magnitude, occur as rock is moving to fill in spaces where magma is no longer present and can cause land to subside or produce large ground cracks (Riley). In addition to being generated after an eruption and magma withdrawal, these earthquakes also occur as magma is intruding upward into a volcano, opening cracks and pressurizing systems (Scott, 2001). Volcano-tectonic earthquakes do not indicate that the volcano will be erupting but can occur at any time and cause damage to manmade structures or provoke landslides.

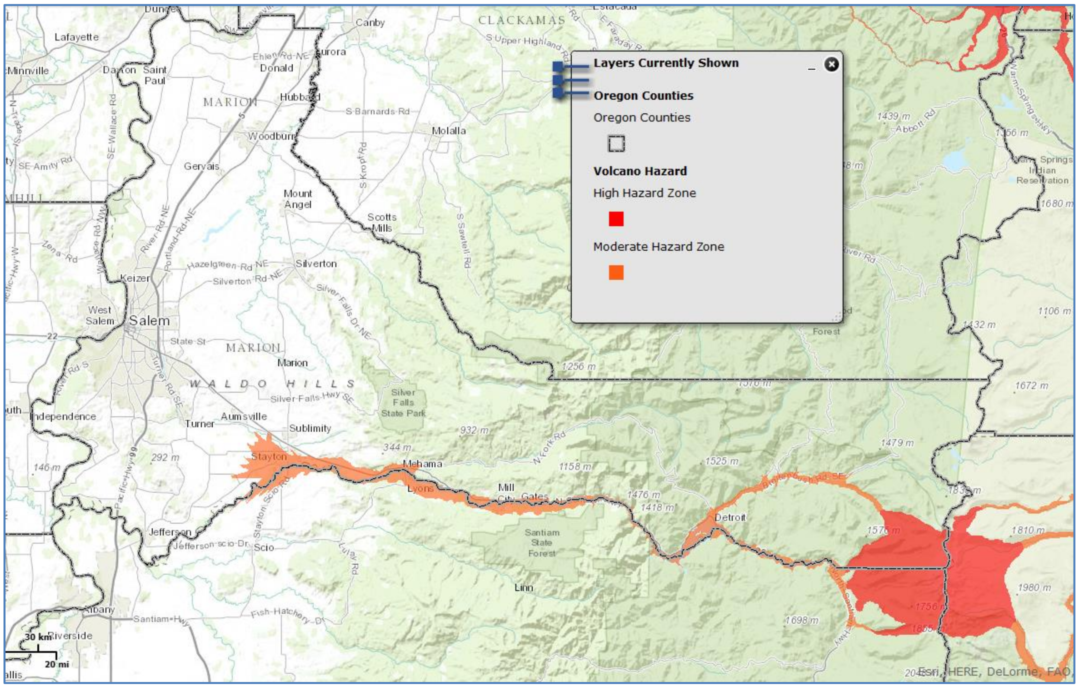
Location and Extent

Volcanic eruption is not an immediate threat to the residents of Salem, as there are no active volcanoes within the city. Nevertheless, the secondary threats caused by volcanoes in the Cascade region must be considered. Volcanic ash can contaminate water supplies, cause electrical storms, create health problems, and collapse roofs.

Salem 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 anywhere along the Cascade Range. Direct impacts from lava are possible in the southeast corner of Marion County in the Cascade Range. Lahar flows are possible along most of Marion County's eastern boarder (see Figure 36) as shown emanating from Mount Jefferson, the closest potential source of volcanic activity. Of particular concern are communities and infrastructure throughout the Santiam Canyon, southwest of Salem. However, ash fall is possible county wide, including Salem, with potential impacts to municipal water and transportation systems as well as sensitive mechanical and electrical equipment. The area affected by ash fallout depends upon the height attained by the eruption column and the atmospheric conditions at the time of the eruption.

Figure 36 below was retained from the Marion County 2022 NHMP update because it shows Marion County along with neighboring Linn County to the south. The plate of the projected location of a lahar from Mount Jefferson into Marion County is included in the DOGAMI Multi-hazard Risk Assessment found in Appendix G.

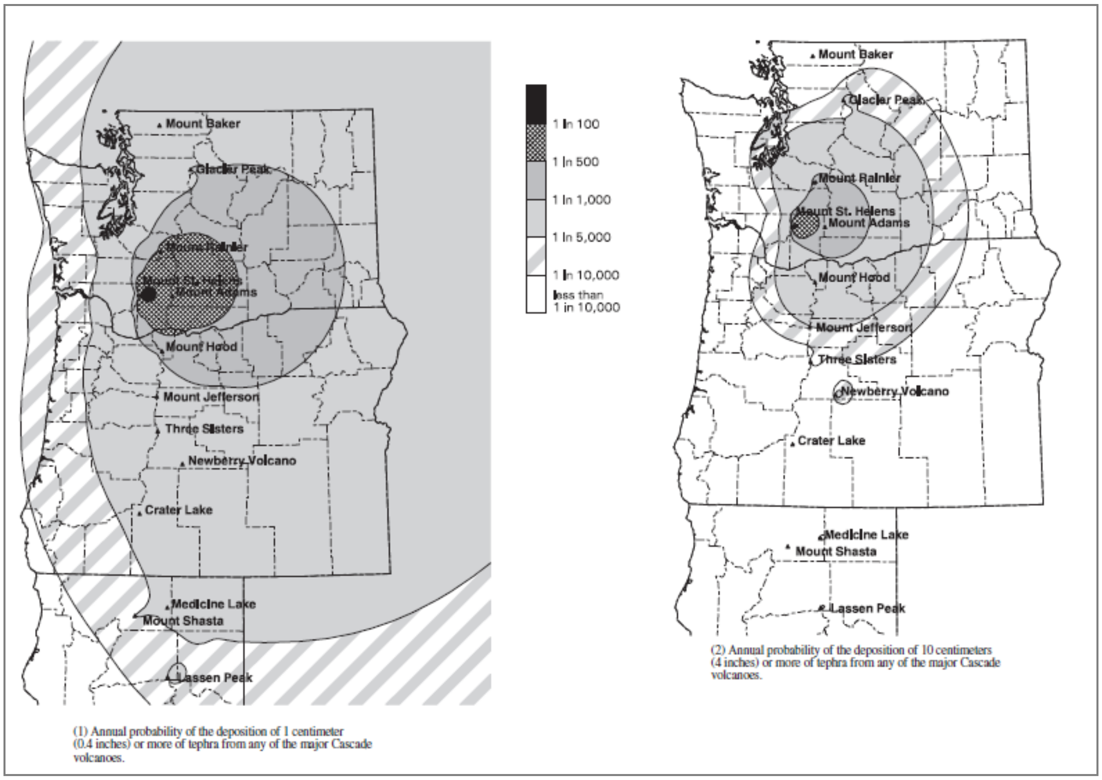
Figure 36 Volcano Hazard, Marion County, Oregon



Source: Oregon Department of Geology and Mineral Industries, Oregon HazVu

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 38 depicts the potential and geographical extent of volcanic ash fall in excess of ten centimeters from a large eruption of Mount St. Helens.

Figure 37 Regional Tephra-fall Maps



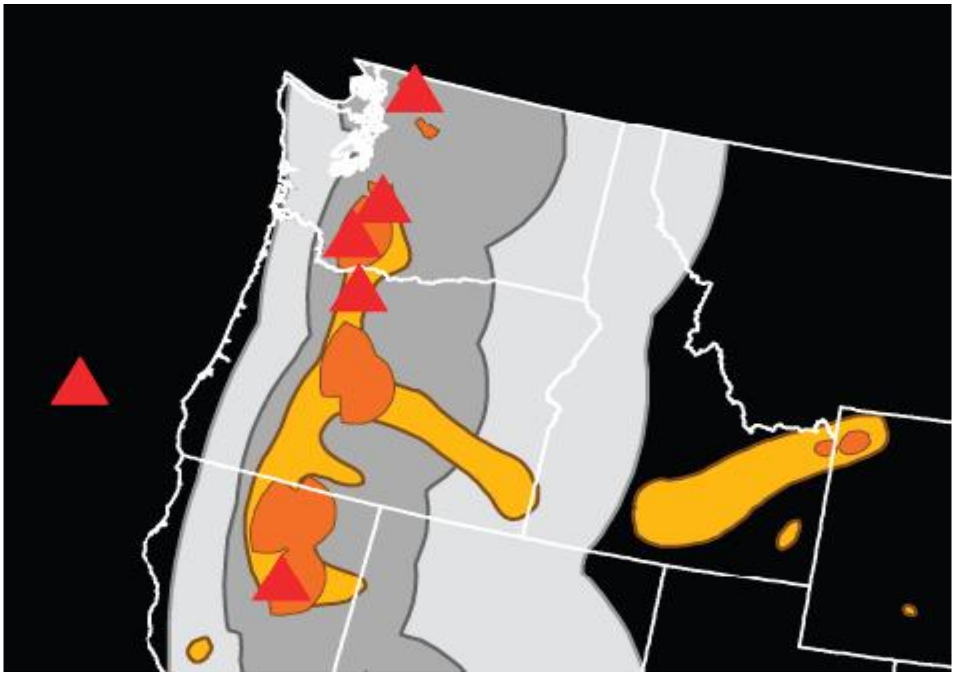
Source: Walder, et al., 2000

Identifying Volcanoes

Communities that are closer to volcanoes may be at risk to the proximal hazards – ash fall, debris avalanches, pyroclastic flows, lahars, and lava flows – as well as the distal hazards – lahars, lava flows, and ash fall. The communities that are farther away are most likely only at risk from the distal hazards (mainly ash fall). Figure 38 shows the locations of some of the Cascade Range volcanoes (red triangles) with relative volcanic hazard zones. The dark orange areas have a higher volcanic hazard; light-orange areas have a lower volcanic hazard. Dark-grey areas have a higher ash fall hazard; light-grey areas have a lower ash fall hazard.

Geologic hazard maps have been created for most of the volcanoes in the Cascade Range by the USGS Volcano Program at the Cascade Volcano Observatory in Vancouver, WA and are available at http://vulcan.wr.usgs.gov/Publications/hazards_reports.html.

Figure 38 National Volcanic Hazard Map



Source: Image modified from U.S. Geological Survey, 2006
Note: The red triangles are volcano locations. Dark-orange areas have a higher volcanic hazard; light-orange areas have a lower volcanic hazard. Dark-gray areas have a higher ash fall hazard; light-gray areas have a lower ash fall hazard. Information is based on data during the past 10,000 years.

Scientists also 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 Cascade Range 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 38 above, depicts the potential and geographic extent of volcanic ash fall from several volcanoes in the Pacific Northwest.

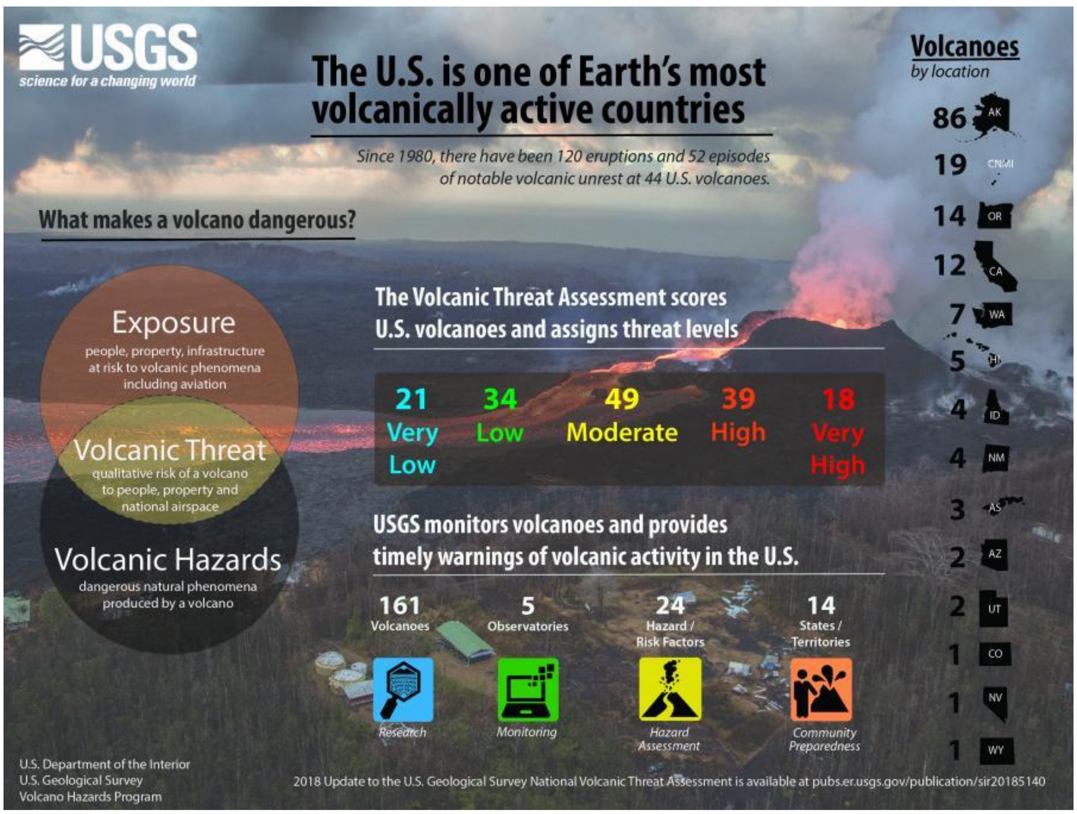
An excellent resource on volcanoes is published by USGS, most recently in 2018, which is called the *National Volcanic Threat Assessment*. The USGS assesses active and potentially active volcanoes in the U.S., focusing on history, hazards and the exposure of people, property and infrastructure to harm during the next eruption. They use 24 factors to obtain a score and threat ranking for each volcano that is deemed potentially eruptible, according to USGS.

In a description on the USGS website "the update names 18 very high threat, 39 high threat, 49 moderate threat, 34 low threat, and 21 very low threat volcanoes. The volcanoes are in Alaska, Arizona, California, Colorado, Hawaii, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, American Samoa and the Commonwealth of the Northern Mariana Islands. The threat ranking is not an indication of which volcano will erupt next. Rather, it indicates how severe the impacts might be from future eruptions at any given volcano."

The USGS website further states, “Since 1980, there have been 120 eruptions and 52 episodes of notable volcanic unrest at 44 U.S. volcanoes. When erupting, all volcanoes pose a degree of risk to people and infrastructure. However, the risks are not equivalent from one volcano to another because of differences in eruptive style and geographic location.”

The USGS describes that the volcanic threat assessment “helps prioritize U.S. volcanoes for research, hazard assessment, emergency planning, and volcano monitoring. It is a way to help focus attention and resources where they can be most effective, guiding the decision-making process on where to build or strengthen volcano monitoring networks and where more work is needed on emergency preparedness and response.”

Figure 39 Volcanic Threat Assessment Statistics

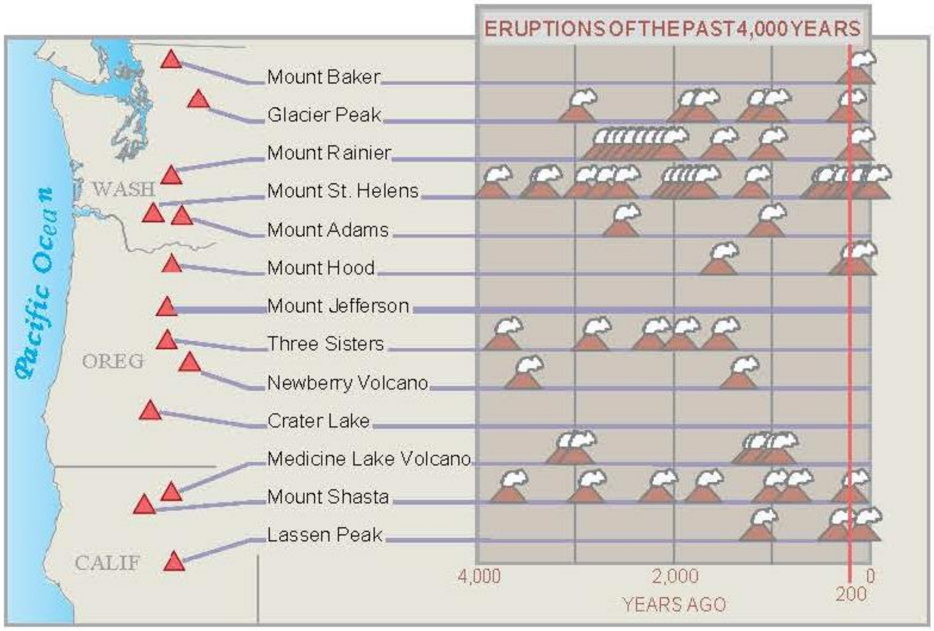


Source: U.S. Geological Survey

History

Although there have been no recent volcanic events in the Marion and Polk County areas, it is important to note the area is active and susceptible to eruptive events since the region is a part of the volcanically active Cascade Range. The 1980 explosion of Mount Saint Helens in southern Washington State is the latest on record. Figure 41 displays the potentially active volcanoes of the western United States as identified by the USGS.

Figure 40 Potentially Active Volcanoes in the Western United States



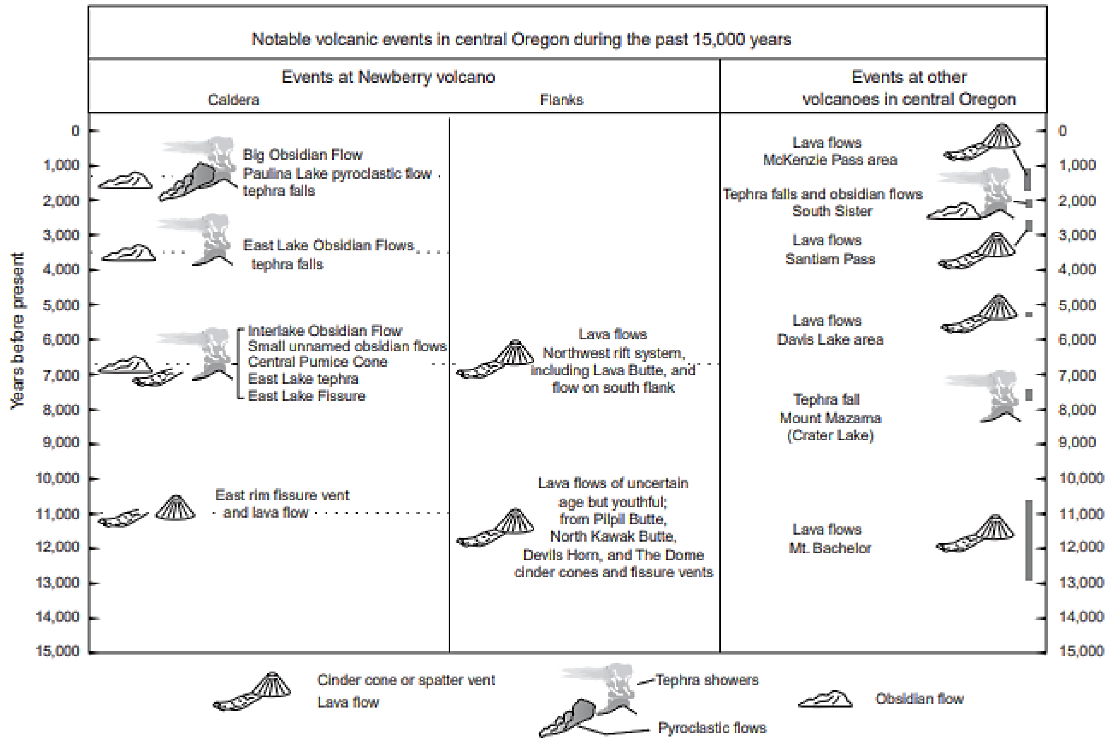
Of the 13 potentially active volcanoes in the Cascade Range of the Pacific Northwest, 11 have erupted in the past 4,000 years. More than 100 eruptions, most of which were explosive, have occurred during that period, making the volcanoes of the Cascade Range some of the most hazardous in the United States. Each eruption symbol in the diagram represents from one to several eruptions closely spaced in time at or near the named volcano. Eruptions have also occurred from other vents (not shown) scattered throughout the Cascade Range, especially in central Oregon and southwestern Washington.

Source: Dzurisin, et al., 2008

There are active volcanic areas that could potentially impact Salem and the broader region. The regional volcanoes identified as very high threat include Mount Rainer, Mount Saint Helens, Mount Hood, Newbery Volcano, Three Sisters (North, Middle, and South Sister), Mount Mazama/Crater Lake, and Mount Shasta. Mount Bachelor falls within the moderate threat category, while Mount Jefferson, Blue Lake Crater, and Belknap Crater are a low threat (Ewert et al., 2018).

Volcanoes in the Cascade Range have been erupting for hundreds of thousands of years. Newberry Volcano, for example, has had many events in the last 15,000 years as shown in Figure 42. The Three Sisters region has also had some activity during this time while the last major eruptive activity at Mount Mazama occurred approximately 7,700 years ago, forming Crater Lake in its wake. Some of the most recent events include Big Obsidian Flow at Newberry Volcano. All the Cascade Range volcanoes are characterized by long periods of quiescence and intermittent activity. And these characteristics make predictions, recurrence intervals, or probability very difficult to ascertain.

Figure 41 Notable Volcanic Events in Central Oregon during the Past 15,000 Years



Source: Sherrod, et al.,1997

In addition to the many online sources of information, a detailed report of the Pacific Northwest's catastrophic hazards and history written by Rick Gore appears in the May 1998 National Geographic, Vol. 193, No. 5. Table 15 describes volcanic events in Oregon and Washington.

Table 15 Significant Historic Volcanic Events

Date	Location	Description
Approximate Years: 18,000 to 7,7000 years before present (YBP)	Mount Bachelor, central Cascades	Cinder cones and lava flows.
20,000 to 13,000 YBP	Polallie eruptive episode, Mount Hood	Lava dome, pyroclastic flows, lahars, and tephra.
13,000 YBP	Lava Mountain, south central Oregon	Lava Mountain field and lava flows.
13,000 YBP	Devils Garden, south central Oregon	Devils Garden field and lava flows.
13,000 YBP	Four Craters, south central Oregon	Four Craters field and lava flows.
7,780 to 15,000 YBP	Cinnamon Butte, Southern Cascades	Balsatic scaria cone and lava flows.

Date	Location	Description
7,700 YBP	Crater Lake Caldera	Formation of Crater Lake caldera, pyroclastic flows, and widespread ashfall.
7,7000 YBP	Parkdale, north central Oregon	Eruption of Parkdale lava flow.
7,000 YBP	Diamond Craters, eastern Oregon	Lava flows and tephra in Diamond Craters field.
<7,700 YBP; 5,300 to 5,600 YBP	Davis Lake, southern Cascades	Lava flows and scoria cones in Davis Lake field.
10,000 to <7,7000 YBP	Cones south of Mount Jefferson; Forked Butte and South Cinder Peak	Lava flows.
4,000 to 3,000 YBP	Sand Mountain, central Cascades	Lava flows and cinder cones in Sand Mountain field.
<3,2000 YBP	Jordan Craters, eastern Oregon	Lava flows and tephra in Jordan Craters field.
3,000 to 1,5000 YBP	Belknap Volcano, central Cascades	Lava flows and tephra.
2,000 YBP	South Sister Volcano	Rhyolite lava flow.
1,500 YBP	Timberline eruptive period, Mount Hood	Lava dome, pyroclastic flows, lahars, and tephra.
1,300 YBP	Newberry Volcano, central Oregon	Eruption of Big Obsidian flow.
1,300 YBP	Blue Lake Crater	Spatter cones and tephra.
1760–1810	Crater Rock/Old Maid Flat on Mount Hood	Pyroclastic flows in upper White River; lahars in Old Maid Flat; dome building at Crater Rock.
1859/1865	Crater Rock on Mount Hood	Steam explosions and tephra falls.
1907 (?)	Crater Rock on Mount Hood	Steam explosions.
1980	Mount St. Helens (Washington)	Mt. St. Helens erupts: Debris avalanche, ashfall, and flooding on Columbia River. 57 people died.
1981-1986	Mount St. Helens (Washington)	Lava dome growth, steam, and lahars.
1989-2001	Mount St. Helens (Washington)	Hydrothermal explosions.
2004-2008	Mount St. Helens (Washington)	Lava dome growth, steam, and ash.

Sources: U.S. Geological Survey; Wolfe & Pierson, 1995; Scott et al., 1997; University of Oregon; *2020 Oregon NHMP;* Federal Emergency Management Agency

A great deal of background information on Oregon and Washington volcanoes and volcanoes in general is available on several websites, including:

- United States Geological Survey (USGS) Volcano Hazards Program: Volcano Hazards | U.S. Geological Survey (usgs.gov) (http://volcanoes.usgs.gov/)

- Department of Geology and Mineral Industries (DOGAMI) Volcano Hazards in Oregon: [DOGAMI Volcano Hazards | Oregon Department of Geology and Mineral Industries (oregongeology.org)]

Future Climate Variability

The causal risk of a volcanic eruption is unrelated to future climate variability, but the potential impact of a volcanic eruption is elevated due to climate-related impacts of drought and wildfire on air quality. That is, air quality trends are expected to be negatively impacted by climate change, so vulnerable populations would be at greater risk of health problems resulting from ashfall or toxic air emissions from an eruption.

Probability Assessment

Based on the available data and research for Salem the NHMP Steering Committee determined the **probability of experiencing volcanic activity is "low,"** meaning one incident is likely within the next 100-year period.

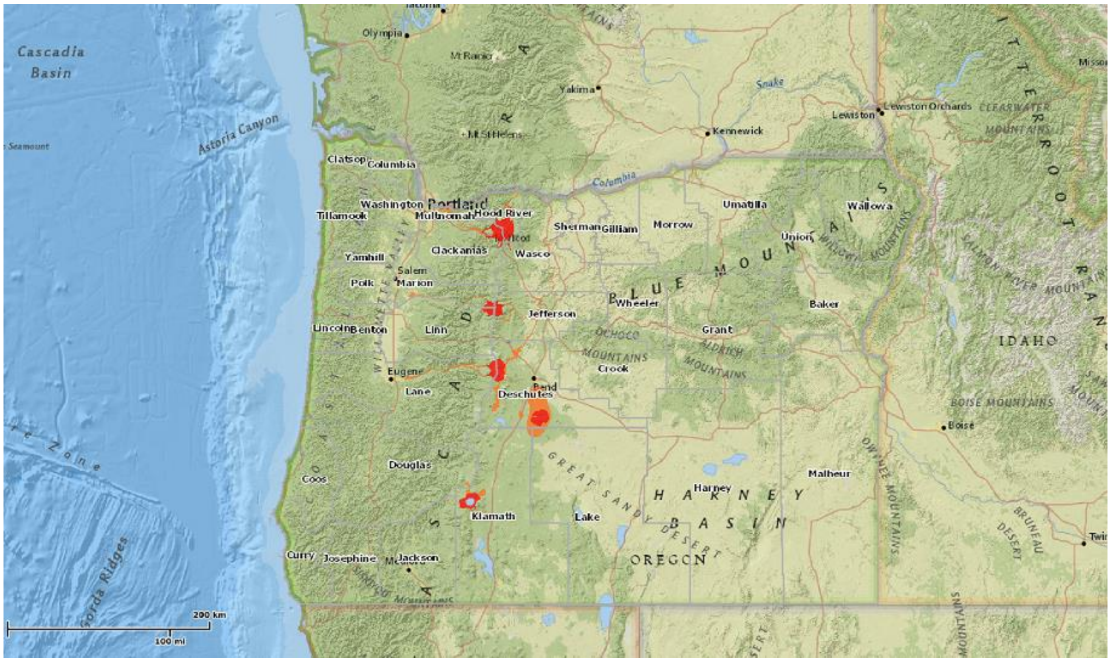
Vulnerability Assessment

The Pacific Northwest region is vulnerable to impacts from volcanic activity. Like the rest of Oregon, Salem has some risk of being impacted by volcanic activity in the Cascade Range. The very high threat volcanoes in the region include Mount Rainer, Mount Saint Helens, Mount Hood, Newbery Volcano, Three Sisters (North, Middle, and South Sister), Mount Mazama/Crater Lake, and Mount Shasta. Because of its geographic distance from these volcanic sites, Salem is not at risk for proximal hazards such as lava flows. However, it is at risk for distal hazards, primarily ash fall (tephra). The location, size, and shape of the area affected by tephra fall is determined by both the vigor and duration of the eruption and the wind direction at the time of eruption, making prediction of the area to be affected impossible more than a few hours in advance. The vulnerability to ash fallout is multi-pronged. For example, ash can disrupt the engines of motor vehicles, reduce visibility, and exacerbate or induce respiratory illnesses.

While a quantitative vulnerability assessment – an assessment that describes number of lives or amount of property exposed to the hazard – has not yet been conducted for Salem volcanic eruption events, there are many qualitative factors – issues relating to what is in danger within a community – that point to potential vulnerability.

Figure 42 shows that that Salem is not within an identified high or moderate volcanic event hazard zone. DOGAMI used data from the USGS Cascades Volcano Observatory for this web application. The Cascades Volcano Observatory maintains proximal and distal hazard zone data for volcanic areas in the Western Cascades of Oregon. These areas include but are not limited to Mount St. Helens, Mount Hood, Crater Lake, Newberry, Mount Jefferson, and the Three Sisters. HazVu shows two hazard zones: the high hazard zone (proximal zone) and moderate hazard zone (distal zone). Mount Bachelor, which is listed as a moderate threat by the USGS (Ewert et al.,2018), is a dormant volcano monitored by the Jaffe Group at the University of Washington at Bothell.

Figure 42 Map of Generalized Vulnerability of the Region



Source: Oregon Department of Geology and Mineral Industries, HazVu

Risks for Salem associated with regional volcanic activity would be ash fall, air quality, 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. Persons with respiratory problems are endangered, transportation, communications, and other lifeline services are interrupted, drainage systems become overloaded/clogged, buildings can become structurally threatened, and the economy takes a major hit. Any future eruption of a nearby volcano (occurring during a period of easterly winds would likely have adverse consequences for the city.

Volcanic eruptions in the past caused multiple minor injuries or a major injury to the health and safety of residents. The potential for future injuries or deaths is anticipated to remain similar to historic events. It is estimated that less than 1% of the City's population would be physically displaced by a volcanic eruption, considering the primary volcanic hazard that could impact Salem is ash fallout, and there would be moderate impact on community social networks.

Several facilities throughout Salem anticipate mild damage due to a volcanic eruption, estimated between $1 million and $10 million for hazard response, structural repairs and equipment replacement. In terms of commercial business, it is likely more than 75% of businesses located in the City and surrounding area would experience commerce interruption for a period of several weeks. Ash fall from volcanic eruptions has the potential to impact a wide region, inflicting damage to building circulation systems and road surface conditions. Lastly, volcanic eruptions would likely have extensive impacts on more than 75% of the City's ecological systems, including, clean water, wildlife habitat, and parks.

According to DOGAMI's *Multi-hazard Risk Report for Marion County, Oregon* (Williams et al., 2022), during a medium zone (1,000 to 15,000 year) lahar scenario, there is the potential to have 7 displaced residents, 4 exposed buildings, none of which are critical facilities. Exposed building value of $772 (exposure ratio 0%).

As such, the NHMP Steering Committee rated the city as having a **"low" vulnerability to volcanic activity**, meaning that less than 1% of the city's population or assets would be affected by a major disaster (volcanic ash)

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

Water Quality/Water Emergency

Significant Changes Since Previous Plan:

The Water Quality/Water Emergency Hazard is new to the Salem NHMP.

Causes and Characteristics

The United States enjoys one of the world's most reliable and safest supplies of drinking water. Moreover, water systems, together with wastewater, is one of 16 critical infrastructure sectors identified by the U.S. Department of Homeland Security. According to the EPA, Approximately 150,000 public water systems, which includes Salem, provide drinking water to most Americans. When the water in our rivers, lakes, and oceans becomes polluted; it can endanger wildlife, make drinking water unsafe, and threaten the waters where we recreate. Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that the water poses a health risk. Some people may be more vulnerable to contaminants in drinking water than the general population, according to the Salem *Annual Water Quality Report 2022*.

The sources of drinking water, both tap water and bottled water, include rivers, lakes, streams, ponds, reservoirs, springs, and groundwater wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals, and in some cases, radioactive materials. In addition, as water travels, it can pick up contaminants resulting from the presence of animal or human activity. As noted in the *Annual Water Quality Report 2022*, Salem regularly monitors activities that may impact its drinking water source, within the North Santiam River Watershed.

Location and Extent

Surface Water

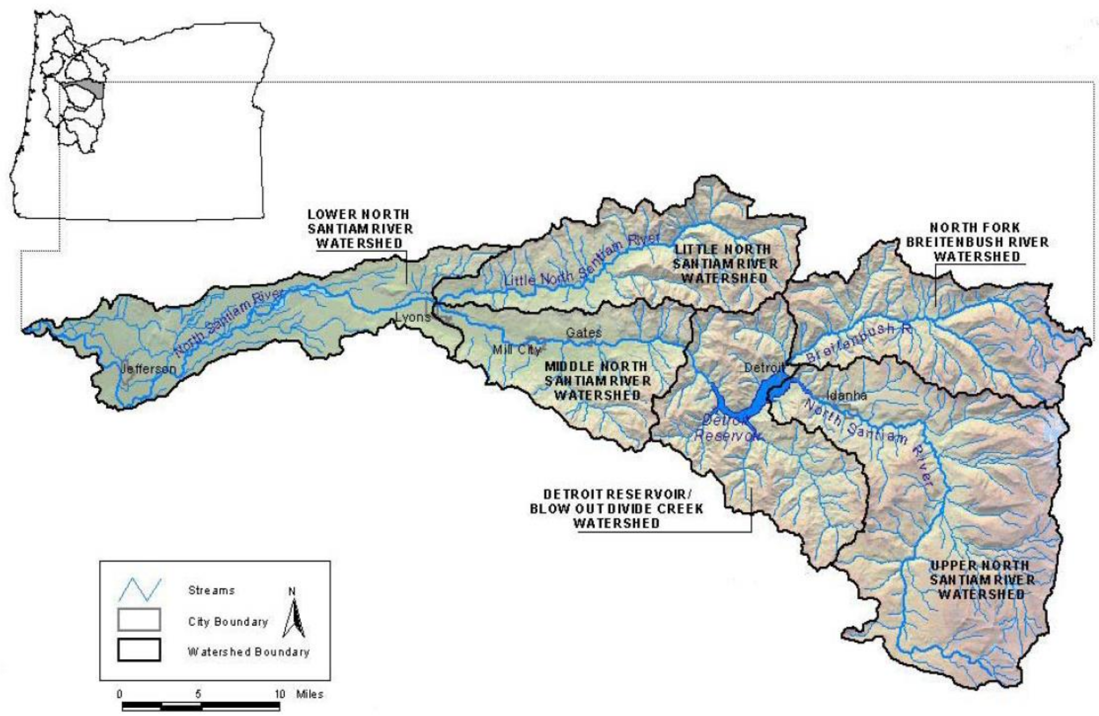
The Willamette Basin encompasses 12 subbasins including the North Santiam. Willamette Basin geographic area comprises the broad Willamette River valley, which is flanked by the forested slopes of the Coast and Cascade Mountain ranges. The Willamette River and its tributaries support a wide variety of ecosystems and habitats including forested and depressional wetlands, riparian forests and shrublands, upland and wet prairies, chapparal, woodlands and oak savanna. Forestry, agriculture and urban uses dominate land use in the Willamette Basin.

According to Salem's *Annual Water Quality Report 2022*, the North Santiam River has served as the primary water source for Salem for over 80 years. Surface water is conveyed by gravity from the North Santiam River, which begins on the west side of the Cascade Range, near Mt. Jefferson and Three Fingered Jack. The North Santiam River flows for over 90 miles from the Cascade Range, through Detroit Reservoir, and toward the Mid-Willamette Valley, ultimately joining the Willamette River. This water source is considered "clean and pristine river water" and high-quality water. The North Santiam River Watershed is an area of about

760 square miles that is surrounded primarily by state and national forest. The North Santiam River also provides water for the many communities along its route.

Based on its high quality, the water from the North Santiam River is “suitable for more natural filtering process called Slow Sand Filtration at the Geren Island Water Treatment Facility located near Stayton.” Geren Island, which is the largest Slow Sand Filtration system in the U.S., has used the Slow Sand Filtration process since the 1930s. However, the facility and processes have improved and changed over time. Salem also utilizes a state-of-the-art ozone treatment system to remove contaminants such as cyanotoxins.

Figure 43 North Santiam Subbasin



Source: Oregon Department of Environmental Quality, 2006.

Salem also holds two water rights to appropriate water from the Willamette River. The city is amid planning efforts to develop infrastructure to use its Willamette River water source, according to the Salem *Water Management and Conservation Plan* (2019).

Figure 44 City of Salem Water System

Source: City of Salem, 2022

Groundwater

Salem has groundwater sources that supplement surface water during emergencies, water quality events, and periods of peak demand. According to Salem's *Water Management and Conservation Plan* (2019), groundwater is appropriated and treated at Geren Island. Salem is exploring the feasibility of developing two additional collector wells on Geren Island to increase its shallow groundwater supply. Salem can appropriate groundwater from three additional wells on Geren Island, if necessary. There is also a limited amount of groundwater available from wells within Salem's water service area.

Aquifer Storage and Recovery

Salem's ASR system provides a supplemental water supply during periods of peak demand or emergencies. The ASR is located underground to store and recover finished water. Treated drinking water from the North Santiam River is injected into the Columbia River basalt aquifer via the ASR wells. The Salem *Annual Water Quality Report 2022* states,

> During the winter months, when flows in the river are high and there is a low demand for water by customers, treated drinking water is injected into the ASR system. The water is stored in a naturally existing groundwater aquifer located 350 feet below Woodmansee Park. During the summer months, when the river is flowing low and customer water demand is high, water is pumped back to the surface, sampled for quality and recovered from the ASR system. The recovered water is treated with calcium hypochlorite (chlorine) for disinfection and then conveyed to the distribution system, serving the south Salem water customers.

Salem began updates to the ASR treatment system in 2021. The updates include corrosion control and a common treatment facility where water recovered from all ASR wells will be disinfected and caustic soda added for pH adjustment.

Water Quality Contaminants

The following are contaminants that may be present in any source water. Contaminants that are monitored by Salem are also identified.

Sediments and Turbidity

This includes loose dirt, topsoil, minerals, sand and silt from roads and highways, excessive removal of vegetation from grazing animals, forest practices, and farming practices.

Microbial Contaminants

Microbial contaminants can include viruses and bacteria, which come from sewage treatment plants, septic systems, agricultural livestock operations and wildlife. This also includes algal blooms, which are a natural process, but certain types of algal blooms known as cyanobacteria can produce cyanotoxins as a defense mechanism.

Microbial contaminants monitored at the Salem facilities include two cyanotoxins: Total Microcystins and Cylindrospermopsin. Other microbiological contaminants monitored are Turbidity, Total coliform, and E. coli bacteria.

Pesticides and Herbicides

These contaminants may come from a variety of sources such as agriculture, road maintenance, individual homes and businesses, and urban stormwater runoff.

Organic Chemical Contaminants

Organic chemicals may include synthetic and volatile chemicals, which are by-products of industrial processes, petroleum processes, wood processes and mills, gas and fueling stations, and auto and mechanical shops.

Organic contaminants monitored at the Salem facilities include Sodium, 2, 4-D, and Hexachlorocyclopentadiene.

Inorganic Contaminants

These contaminants include salts and metals, which can occur naturally in the geology, or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas productions, and mining or agriculture.

Inorganic contaminants monitored at the Salem facilities include Fluoride, Copper, Nitrate, Nitrate-Nitrite, Barium, and Lead.

The Salem facilities also monitors for the following disinfection by-products, by-product precursors, and disinfectant residual contaminants: Haloacetic acids, Total Trihalomethanes, Total Organic carbon, and Chlorine Residual.

Radioactive Contaminants

Radioactive contaminants can be naturally occurring or be the result of oil and gas production, and mining activities.

Radioactive contaminants monitored at the Salem facilities include Gross Beta Particle Activity.

Identifying Water Quality Hazards

According to DEQ, Oregon is required to establish Total Maximum Daily Loads (TMDL) for streams segments which do not meet water quality standards. This information identifies the level of contaminants that a water body can absorb and still meet water quality standards. Moreover, TMDLs consider contaminants from all sources including discharges from industry and sewage treatment facilities; runoff from farms, forests and urban areas; and natural sources. Also included are safety margins to account for uncertainty. This information is then used to determine what changes must take place to achieve water quality standards. Water quality management plans (WQMP) are also developed based on the TMDLs. These plans document the ways that local landowners, local and federal agencies, forest and agricultural land managers, DEQ and others will implement a specific TMDL and work to improve water quality (DEQ, TMDL Program: Willamette Basin).

DEQ has established TMDLs to address elevated temperature and mercury levels throughout the North Santiam and South Santiam Subbasins. In addition, DEQ has planning targets for bacteria in the urban and agricultural areas, which are addressed in the WQMP.

In addition to the TMDL program addressed above, in compliance with the Federal Safe Drinking Water Act (EPA sets legal limits on over 90 contaminants in drinking water), Salem routinely collects and tests water quality samples for possible contaminants. Moreover, Salem regularly monitors unregulated contaminants in drinking water such as per- and polyfluoroalkyl substances – known as PFAS or forever chemicals. However, the City of Salem is most concerned about harmful algal blooms (HABS) of which the associated health advisory levels are discussed below. Sampling and monitoring procedures occur within the distribution system (in town), at Geren Island, and at several locations in the North Santiam River watershed.

Under normal conditions for monitoring the distribution system, Salem collects water quality samples from 48 different locations. These sample locations were chosen with the assistance of the Oregon Health Authority Drinking Water Program and are strategically located to provide monitoring in all areas of the distribution system. A bacteriological sample, in addition to temperature, pH, turbidity, chlorine residuals, and additional water quality parameters are routinely collected. Additional sampling in the distribution system occurs for asbestos, Stage 2 Disinfectants and Disinfection Byproducts, and lead and copper.

Salem also samples inorganic contaminants (IOCs), synthetic organic contaminants (SOCs), volatile organic contaminants (VOCs). Nitrate, nitrite, arsenic, and radiological contaminants at the entry point to the distribution system on sampling intervals as required in the Federal Safe Drinking Water Act.

The Drinking Water Monitoring Program indicates that a summary of the water quality data collected each year is compiled in Salem's *2022 Annual Water Quality Report*. The 2022 report it states, "In 2021, the City of Salem drinking water met or surpassed every public health requirement—more than 120 drinking water standards—set by the Oregon Health Authority and the EPA."

Salem also monitors conditions in the North Santiam River and Detroit Reservoir. Algae and cyanotoxins, in addition to other water quality parameters, are monitored in the watershed. According to the Oregon Health Authority, drinking water systems using surface water sources susceptible to harmful algal blooms (HABS) shall be routinely tested for two cyanotoxins – total microcystins and cylindrospermopsin. The Oregon Administrative Rules use the health advisory levels established by EPA for these two are the identified below and at such time, after following cyanotoxin monitoring requirements for finished drinking water, will trigger the jurisdiction to issue a "Do-Not-Drink Advisory" within 24 hours to users of the water system and purchasers:

Total Microcystins

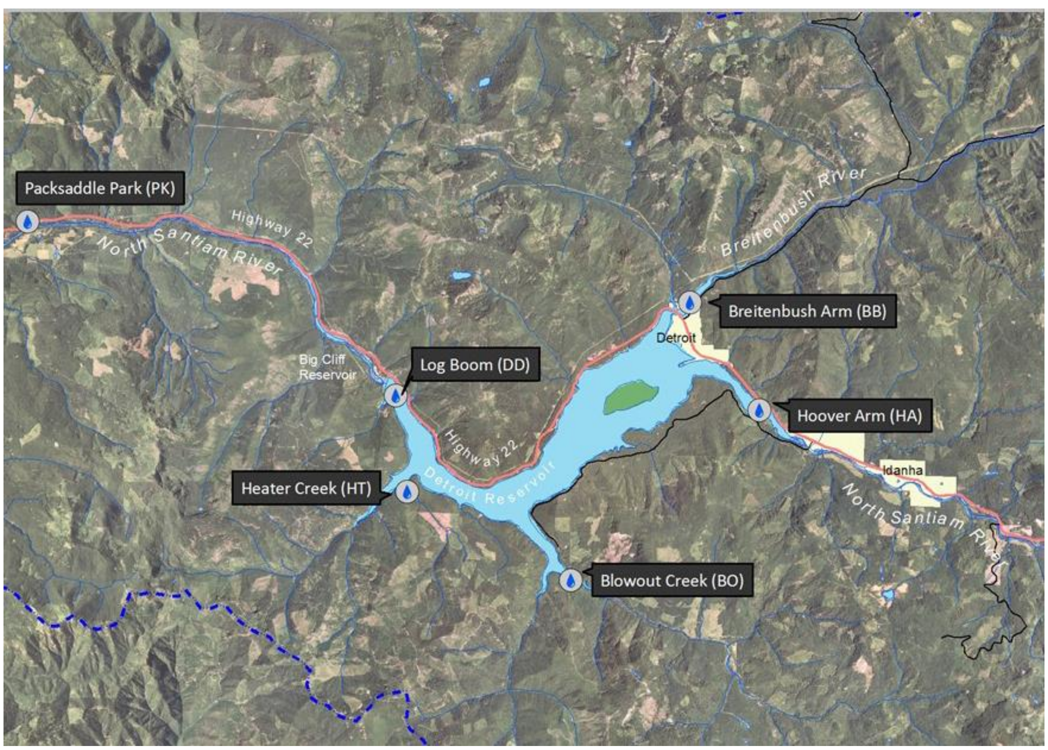
- For Vulnerable People: 0.3 ug/L or ppb (parts per billion)
- For Anyone: 1.6 ug/l or ppb

Cylindrospermopsin

- For Vulnerable People: 0.7 ug/L or ppb
- For Anyone: 3 ug/l or ppb

The Data collected from the watershed can be used to adjust drinking water treatment processes at Geren Island, if needed. Monitoring in the watershed typically begins in April or May and ends in September or October, depending on the weather conditions and Detroit Reservoir water levels. Figure 45 shows the Salem watershed sampling locations.

Figure 45 Salem Watershed Sampling Locations



Source: City of Salem

History

Salem's service population within the City of Salem in 2017 was 163,480, according to the *Water Management and Conservation Plan* (WMCP), which states,

> The City provides water to its retail customers and three wholesale customers outside city limits (Suburban East Salem Water District, City of Turner, and Orchard Heights Water District). The City's retail customers include customers within city limits as well as customers outside city limits, such as the Jan Ree area located within the northeast portion of the service area. The City estimates that its water service population in 2017 was 195,816. The City's total water service population includes populations within the City of Salem, the City of Turner (wholesale customer), Suburban East Salem Water District (wholesale Customer), Jan Ree Area, Eola-Chatnicka Area, and Orchard Heights Water District (wholesale customer).

Salem has nine customer categories for water: residential, multi-family, commercial, industrial, institutional, public, irrigation, wholesale, and fire services, which are further defined in the *Water Management and Conservation Plan*. The number of service connections for each customer category is identified in the following table.

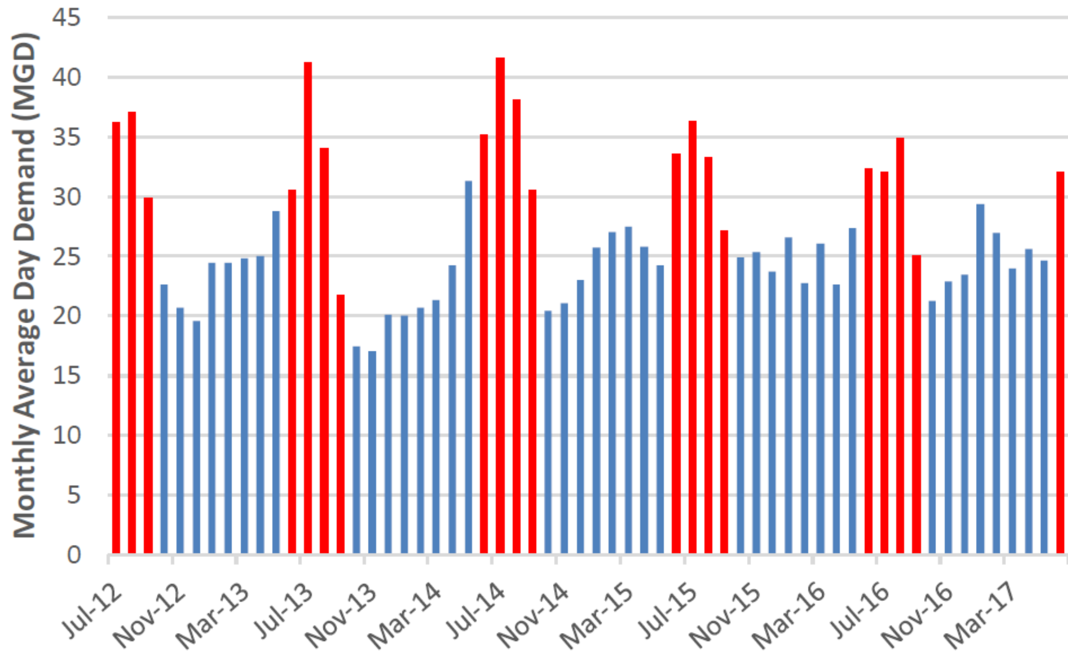
Table 16 Number of Service Connections, Fiscal Year 2016-2017

Customer Category	Number of Connections
Residential	42,605
Multi-Family	2,279
Commercial	2,931
Industrial	19
Institutional	8
Irrigation	655
Public	125
Wholesale	3
Total	48,625

Source: City of Salem, 2019

Salem's WMCP provides information regarding water sources, demands, conservation, and curtailment. The WMCP also provides data on average annual, seasonal, monthly, daily, and per capita demands; in addition to, historic water loss. Figure 47 below shows the monthly average day demand between July 2012 and June 2017.

Figure 46 Salem Monthly Average Day Demand, July 2012 to June 2017



Source: City of Salem, 2019
Note: Red indicates peak season months (June through September) while blue indicates non-peak season months

According to the WMCP, Salem has experienced a curtailment episode that stemmed from a series of events. The curtailment event occurred in July 2009 and was caused by the following conditions and events:

- Typical high summer water demands
- Reduced storage capacity because of required reservoir repairs
- Reduced production at Geren Island because of an algae bloom in Detroit Reservoir on the North Santiam River
- Reduced supply (i.e., flow) because of gate failures at Big Cliff Dam

A Level 2, voluntary, curtailment occurred between July 28, 2009 and August 2, 2009. During that curtailment, the following measures were implemented:

1. Salem customers were requested to suspend outdoor water uses, including car washing, sidewalk and patio cleaning, and residential lawn and turf watering. Garden watering was permitted.
2. Salem suspended irrigation at City parks. Watering of sensitive areas and areas actively being used for tournaments was permitted.
3. Salem suspended water supply to decorative fountains. Splash pads were kept in operation for recreation, to encourage citizens to use these facilities rather than residential irrigation systems.

Backup water supplies exist in the form of interties with other water providers, groundwater and the City's ASR system, according to the WMCP. Interties agreements with the Cities of

Stayton and Keizer can provide some water to Salem; however, agreements with the cities do not guarantee water during an emergency event. The ASR wells and local wells can also provide limited water supply, but some wells "would require three to four weeks to activate…." The WMCP states, "Utilizing all of these available backup resources, Salem could produce up to 36.25 cfs (23.5 mgd). This is compared to an average day demand of finished water over the five-year period from FY 2012-2013 through 2016-2017 of 42.9 cfs (27.7 mgd)."

The USGS Oregon Water Science Center provides the following summary of the water quality issue that occurred in 2018 and the reason behind why the Salem NHMP Steering Committee elected to include the water quality/water emergency hazard to Salem's NHMP.

> Harmful algal blooms (HABs) have occurred in many of the large water storage reservoirs in the Willamette River Basin, resulting in health advisories for water contact recreation, and in 2018 for the first time in Oregon, a drinking water advisory due to cyanotoxins. A HAB in Detroit Lake during spring produced cyanotoxins that were transported downstream in the North Santiam River, affecting the State capital of Salem's drinking water for about a month. Similar types of cyanobacterial blooms occur in Blue River and Cougar Reservoirs, in the McKenzie River Basin, with similar threats to drinking water for the City of Eugene.
>
> To address this issue, and to complement on-going limnological surveys, the USGS partnered with the City of Salem, the Eugene Water and Electric Board, and the U.S. Army Corp of Engineers to monitor algal blooms in Detroit Lake and nearby Cougar Reservoir – and the downstream rivers – using continuous water-quality monitors that transmit data to water treatment plant operators, dam operations, researchers and the public in near real-time. Basic parameters, including water temperature, conductance, and turbidity, are collected vertically in the reservoirs approximately every meter for the top 10 meters, then every 5 meters down into the hypolimnion (bottom waters) to a maximum of 75-90 meters (230-295 feet) deep. HAB parameters include surrogates for algal biomass (total chlorophyll [fCHL] and blue-green pigment phycocyanin [PC]), indicators of photosynthetic activity (dissolved oxygen and pH) and fluorescing dissolved organic matter [fDOM] that is often a reliable surrogate for dissolved organic carbon. Each of these parameters is monitored hourly at the surface (~1-meter depth) and through the water column multiple times per day from locations near dam (at the log booms). Data are available (per parameter) as: Profiles with a slider scale to portray conditions with depth over time; Time-series plots, based on the hourly data collected at 1-meter depth; and in Contours, color plots of parameter values by depth over time. When taken together with the downstream continuous water-quality monitors these data provide an early-warning indicator of an algal bloom in the reservoir, or the possible release and transport of algae downstream to drinking-water intakes. These data also provide insights into the evolution, behavior, and decay of the seasonal blooms which can inform management strategies, modeling, and perhaps prediction of blooms in the future.[8]

[8] HAB Site USGS 444306122144600, Detroit Lake at Log Boom Behind Detroit Dam, OR.

Future Climate Variability

In the *2023 Salem NHMP*, there are several locations that describe future changing conditions or climate change as it relates to the natural hazards that impact Salem and the surrounding area. In the order of appearance in the NHMP it is in the Risk Assessment and the Hazard Characterizations.

The Willamette River at Salem is currently rain-dominated, whereas the Santiam River at Detroit Dam is in mix of rain-and-snow basin in which flow peaks during winter and during spring snowmelt. How such changes in frequency of rain-on-snow events are likely to affect streamflow, according to the OCCRI *Future Climate Projections Marion County, Oregon*. The report continues,

> 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 to result from increases in the intensity of heavy precipitation; warmer temperatures that cause more precipitation to fall as rain and less as snow, in turn causing snow to melt earlier in spring; and increasing winter precipitation and decreasing summer precipitation (Dalton *et al.*, 2017; Mote *et al.*, 2019; Dalton and Fleishman, 2021).

According to the Salem WMCP, future curtailment episodes could occur because of "significant drought affecting North Santiam River flow, failure of aging infrastructure, flooding and high turbidity events affecting filtration at Geren Island, system wide earthquake damage, or other catastrophic events that may affect water supply." Furthermore, a wildfire event will affect water balance, water quality, fluvial and riparian systems, and water infrastructure, according to OCCRI *Fifth Oregon Climate Assessment* (2021).

Regarding the water infrastructure and supply, the *Fifth Oregon Climate Assessment* (2021) states,

> Climate change-induced shifts in precipitation and rising temperatures are affecting the quantity and quality of Oregon's surface water and groundwater (*State of Climate Science*, this volume), and threaten the ability of water infrastructure systems to provide expected and timely services. …
>
> Projected drier summers and reduced snow-to-rain ratios (*State of Climate Science*, this volume), exacerbated by groundwater depletion in some regions, threaten the ability of existing water supply infrastructure to meet the growing demand for multiple uses of water (e.g., domestic, industrial, irrigation, recreation) (Clifton et al. 2018). The shift in seasonal flows may require adjustments to existing irrigation infrastructure, such as canals, pipes, storage reservoirs, ponds, and wells. Seasonal changes also may warrant adjustments to water rights, ideally allowing reused and other sources of water to be leveraged or existing resources to be conserved (Jaeger et al. 2017, ASCE 2019) to ensure that the water supply is reliable, water quality regulations are met, costs are managed, and systems are maintained. Adjustments by water utilities may include improving the efficiency of the distribution system to

minimize losses (CPMC 2014a, b), promoting conservation behaviors and technologies (e.g., changes to building and plumbing codes; conversion of treated wastewater to potable water [ASCE 2019]), and identifying alternate sources and opportunities for enhancing storage capacity.

The *Salem Climate Action Plan 2021,* includes numerous strategies to address a variety of climate-related challenges, including warming temperatures, changing precipitation patterns, and increased risk of wildfire. Some of the most significant projected climate impacts are the following, some or all of which will impact water quality for the City of Salem:

- The number of days with a heat index over 90°F will increase from a historic average of 7 per year to 33 per year by mid-century.
- Hotter and drier conditions are likely to cause more frequent droughts.
- More intense rainfall and rain-on-snow events could also lead to flood events in areas outside of historical high-risk zones.
- Wildfire is a significantly increasing risk across the state of Oregon. The number of extreme fire danger days in Salem will double by mid-century, increasing from a historic average of 10 per year to 20 per year. Extremely large, intense fires will become more likely under hotter and drier climate scenarios.
- Poor to hazardous air quality resulting from wildfires could greatly impact unsheltered populations and people with underlying health issues such as asthma, diabetes and obesity.

Probability Assessment

While it rarely occurs, water quality may become unsafe to drink or use otherwise because of a natural disaster or high levels of contaminants in the water source. Salem has begun to recognize the impacts of poor water quality with climate-related challenges such as warming temperatures, changing precipitation patterns, and increased risk of wildfire.

Based on the available data and research for Salem, the NHMP Steering Committee assessed the **probability of experiencing a water quality hazard as "high,"** meaning one incident is likely within a 10 to 35-year period.

Vulnerability Assessment

Salem has nine customer categories for water that include residential, multi-family, commercial, industrial, institutional, public, irrigation, wholesale, and fire services. When water quality emergencies occur, all sectors are impacted. Through the Salem WMCP, proactive measures are outlined in water curtailment plans. The intent of a curtailment plan is to minimize the impact of water supply shortages, which may result from incidents such as prolonged drought, mechanical or electrical equipment failure in the system, unanticipated catastrophic events (flooding, landslides, earthquakes and contamination), or events not under control of the water supplier (e.g., localized or area-wide power outages, harmful algal blooms, high turbidity, and intentional malevolent acts).

Salem Climate Action Plan 2021

The *Salem Climate Action Plan 2021* outlines the following potential vulnerabilities and consequences of various projected climate changes as it relates to water quality and supply.

Projected Temperature Increases

The issue of increasing cyanotoxins in drinking water due to algal blooms would be a significant risk to Salem's residents if not for the important water treatment efforts already underway.

- Warming temperatures will likely lead to sustained or increased frequency of cyanotoxins, or harmful algal blooms, in the freshwater systems surrounding Salem. Exposure to cyanotoxins can cause hay fever-like symptoms, skin rashes, respiratory and gastrointestinal distress, and drinking untreated water containing cyanotoxins can cause liver and kidney damage. Salem has been monitoring and treating drinking water for cyanotoxins for years, and recently invested in a new ozone filtration system at the Geren Island water treatment plant to ensure drinking water for residents will continue to be safe. But recreational activities in local lakes and rivers could be inhibited.
- Decreased water levels in the reservoirs on the North Santiam River which provide all of Salem's water.

Projected Precipitation Patterns

Though overall precipitation amounts are expected to remain consistent, increased temperatures noted above will lead to a water deficit. This deficit may impact water supply and demand for the nine customer categories that Salem provides water, including residential, multi-family, commercial, industrial, institutional, public, irrigation, wholesale, and fire services. Precipitation patterns may change, leading to increased frequency of heavy downpour events and flooding, which can also have an impact on water quality.

- Water use restrictions and food insecurity in periods of drought.

Projected Wildfire Risk

Increased temperatures and drier conditions will lead to increased fire risk in forested areas outside of Salem and in the North Santiam Watershed, where Salem's water source originates.

- Salem's drinking water source, the North Santiam River, could be degraded. Debris and chemicals in surface water following a fire could put additional pressure on water treatment facilities. The Geren Island water treatment plant could itself be at risk of wildfire.
- Higher than expected population growth. If people choose to relocate from other areas with higher climate change risk, the population influx could strain existing resources, services, and contribute to housing-related issues.

The Salem NHMP Steering Committee rated the city as having **a "moderate" vulnerability to water quality hazards**, meaning between 1 to 10% of the city's population or property would be affected by a major water quality emergency or disaster.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

Wildfire

Significant Changes Since Previous Plan:

The Wildfire Hazard section was reformatted and expanded with additional information since the previous plan. The 2017 Marion County Community Wildfire Protection Plan is incorporated where applicable in this plan.

Causes and Characteristics

Wildfire is defined as an uncontrolled burning of wildland (forest, brush, or grassland). Wildfires occur in areas with large amounts of flammable vegetation that require a suppression response due to 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 in moving away from built-up urban areas, they have also left behind readily available fire services providing structural protection.

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

Topography

Topography influences the movement of air and directs a fire’s course. Slope and hillsides are key factors in fire behavior. Hillsides with steep topographic characteristics are often also desirable areas for residential development. In parts of Salem, much of the topography is hilly or mountainous which can exacerbate wildfire hazards. These areas can cause a wildfire to spread rapidly and burn larger areas in a shorter period, especially, if the fire starts at the bottom of a slope and migrates uphill as it burns. Wildfires tend to burn more slowly on flatter lying areas, but this does not mean these areas are exempt from a rapidly spreading fire. Hazards that can affect these areas after the fire has been extinguished include landslides (debris flows), floods, and erosion.

Fuel

Fuel is the material that feeds a fire. Fuel is classified by volume and type. 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 is increased 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 hazards, 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.

Development

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 in moving away from urban areas, they have left behind readily available fire services providing structural protection. Rural locations may be more difficult to access and or simply take more time for fire protection services to get there. Looking at important climate projections described in the 2020 Oregon NHMP, it is likely these situations are exacerbated by changes in the climate.

Location and Extent

Wildfire hazard areas are commonly identified in regions of the Wildland Urban Interface (WUI). The WUI occurs where wildland and developed areas meet or intermingle with both vegetation and structural development combining to provide fuel. If left unchecked, it is likely that fires in these areas will threaten lives and property. One challenge Salem 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.

Ranges of the wildfire hazard are further determined by the ease of fire ignition due to natural or human conditions and the difficulty of fire suppression. The wildfire hazard is also magnified by several factors related to fire suppression/control, such as the surrounding fuel load, weather, topography, and property characteristics.

Fire susceptibility throughout the city dramatically increases in late summer and early autumn as summer thunderstorms with lightning strikes increases and vegetation dries out, decreasing plant moisture content and increasing the ratio of dead fuel to living fuel. However, various other factors, including humidity, wind speed and direction, fuel load and fuel type, and topography can contribute to the intensity and spread of wildfire. In addition, common causes of wildfires include arson and negligence from industrial and recreational activities.

While Salem does not have a specific wildfire management plan, the city is included in the *Marion County Community Wildfire Protection Plan* (CWPP). One of the core elements of a CWPP is developing an understanding of the risk of potential losses to life, property, and natural resources during a wildfire. This risk assessment adopts the approach produced by ODF under the National Association of State Foresters (NASF) guidance which includes the following three risk objectives:

- Identify Communities-at-Risk and the Wildland-Urban Interface
- Develop and conduct a wildfire risk assessment of all land in Marion County, surrounding the City of Salem.
- Identify and prioritize hazardous fuels treatment projects for all land in Marion County.

The Marion County wildfire risk assessment is the analysis of the potential losses to life, property, and natural resources. The analysis takes into consideration a combination of factors defined below:

Risk: the potential and frequency for wildfire ignitions (based on past occurrences).

Hazard: the conditions that may contribute to wildfire (fuels, slope, aspect, elevation and weather).

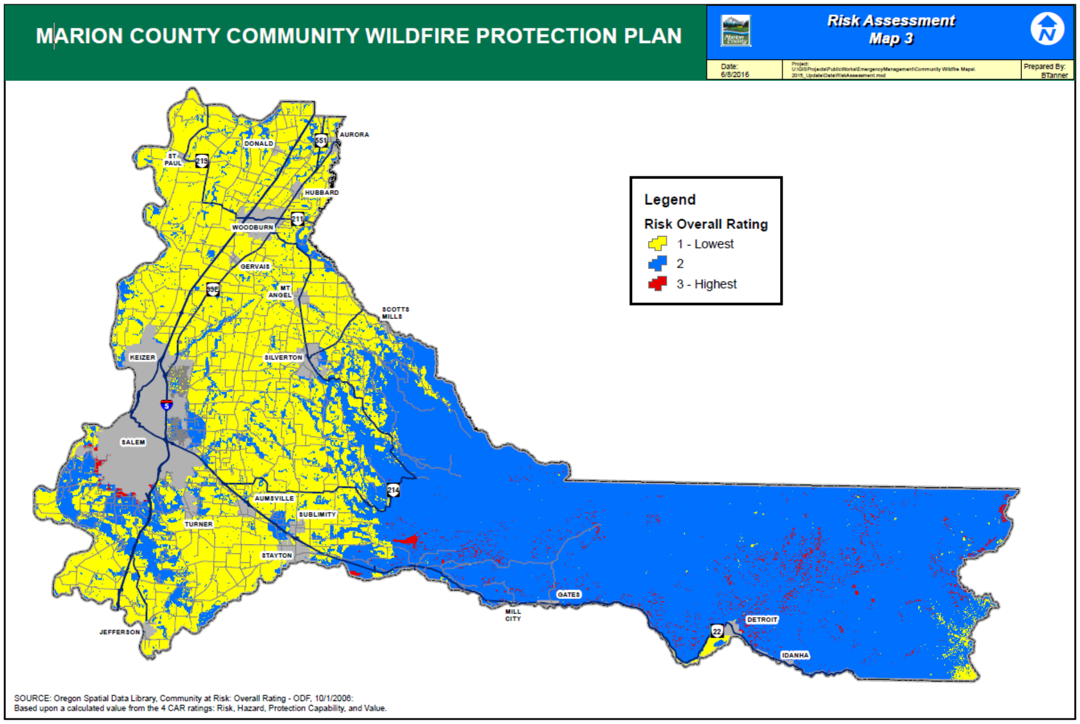
Values: the people, property, natural resources and other resources that could suffer losses in a wildfire event.

Protection Capability: the ability to mitigate losses, prepares for the hazard, responds to and suppresses wildland and structural fires.

Structural Vulnerability: the elements that influence the level of exposure of the hazard to the structure (roof type and building materials, access to the structure, and whether there is defensible space or fuels reduction around the structure.

The Marion County CWPP identifies Salem (south and east) as an at-risk community based upon residential density and Fire District serviceability. The extent of damage to Salem from WUI fires is dependent on many factors, including temperature, wind speed and direction, humidity, proximity to fuels, and steepness of slopes. WUI fires can be intensified by development patterns, vegetation, and natural fuels, and can merge into unwieldy and unpredictable events. Figure 48 shows the overall risk rating for Marion County.

Figure 47 Marion County Wildfire Risk Assessment Map



Source: Marion County, 2017

Updated wildfire risk assessment information is now available through the West Wide Wildfire Risk Assessment (WWA).[9] The WWA, a multi-state assessment, provides multiple data sets that can be used to evaluate and weight the relative risk of various factors that contribute to wildfire risk. Because of the scale, modeling and assumptions that went into creating the WWA, caution is needed when interpreting the data at the local level. The ongoing CWPP update process will assess this new data and determine its relevance to wildfire risk and mitigation strategies in Marion County. Initial analysis of the WWA data does not indicate a significant variance from the analysis used in the Marion and Polk CWPPs.

Identifying Wildfire

The first phase of wildfire-hazard assessment is identification. Hazard identification identifies the geographic extent of areas subject to wildfire, expected intensity of a wildfire event at different locations, and probability of occurrence of wildfire events. In addition, the level of wildfire hazard is determined by the ease of fire ignition, natural or human cause, and difficulty of fire suppression. Wildfire hazard can be magnified by several fire suppression and control factors, such as the fuel load, weather, topography, and property characteristics.

[9] The Oregon Department of Forestry, on behalf of the Council of Western State Foresters (CWSF) and the Western Forestry Leadership Coalition (WFLC), has conducted a wildfire risk assessment and report for the 17 western states and selected U.S. affiliated Pacific Islands. At the highest level, this assessment is known as the West Wide Wildfire Risk Assessment, or WWA (Oregon Department of Forestry, 2016).

The use of Geographic Information System (GIS) tools and improved data can assist in fire hazard assessment, allowing further integration of fuels, weather, topography, and development data for fire behavior prediction, watershed evaluation, developing mitigation strategies, and hazard mapping.

According to the National Wildfire Coordinating Group (NWCG) *Glossary of Wildland Fire Terminology* (2012), wildfire can be divided into three main categories: interface, wildland, and firestorms. These descriptions are provided for a brief but comprehensive understanding of wildfire.

Interface or Wildland Urban Interface (WUI) Fires

An interface fire occurs where wildland and developed areas, structures and other human development, meet or intermingle with both vegetation and structural development combining to provide fuel. Figure 49 below illustrates higher risk areas of Salem's interface. This information was developed from the ODF wildfire risk classification data.

Wildland Fires

Wildland is an area where development is essentially non-existent, except for roads, railroads, powerlines, and similar transportation facilities. Structures, if any, are widely scattered. A wildland fire's main fuel source is natural vegetation. Often referred to as forest or rangeland fires, these fires occur in national forests and parks, private timberland, and on public and private rangeland. A wildland fire can become an interface fire if it encroaches on developed areas. Three distinct types of wildland fire include wildfire, wildland fire use, and prescribed fire, and are further defined below by the NWCG *Glossary of Wildland Fire Terminology* (2012).

Wildfire

An unplanned, unwanted wildland fire including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, and all other wildland fires where the objective is to put the fire out.

Wildland Fire Use

The application of the appropriate management response to naturally-ignited wildland fires to accomplish specific resource management objectives in pre-defined designated areas outlined in Fire Management Plans. Operational management is described in the Wildland Fire Implementation Plan (WFIP).

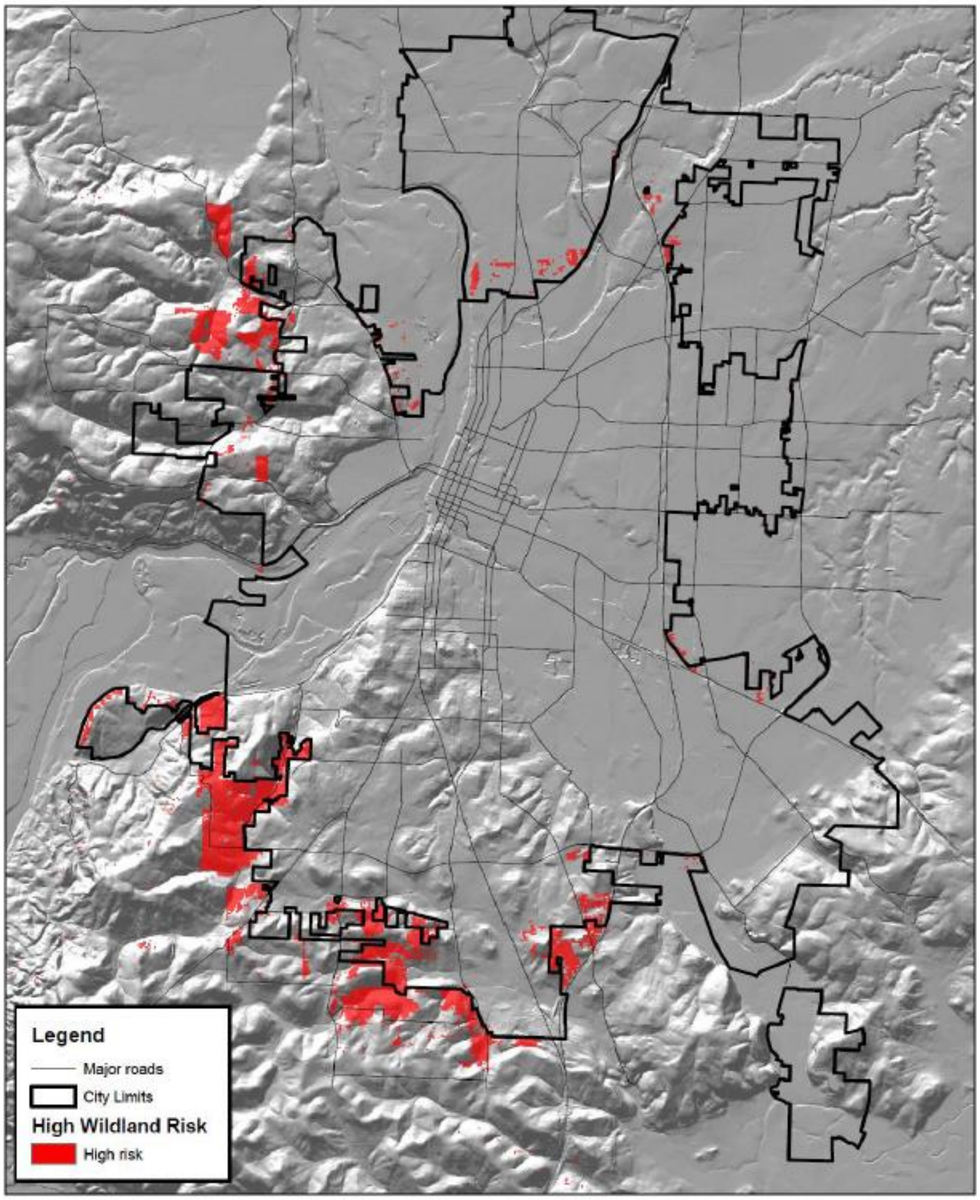
Prescribed Fire

Any fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist, and NEPA requirements (where applicable) must be met, prior to ignition.

Fire Storms

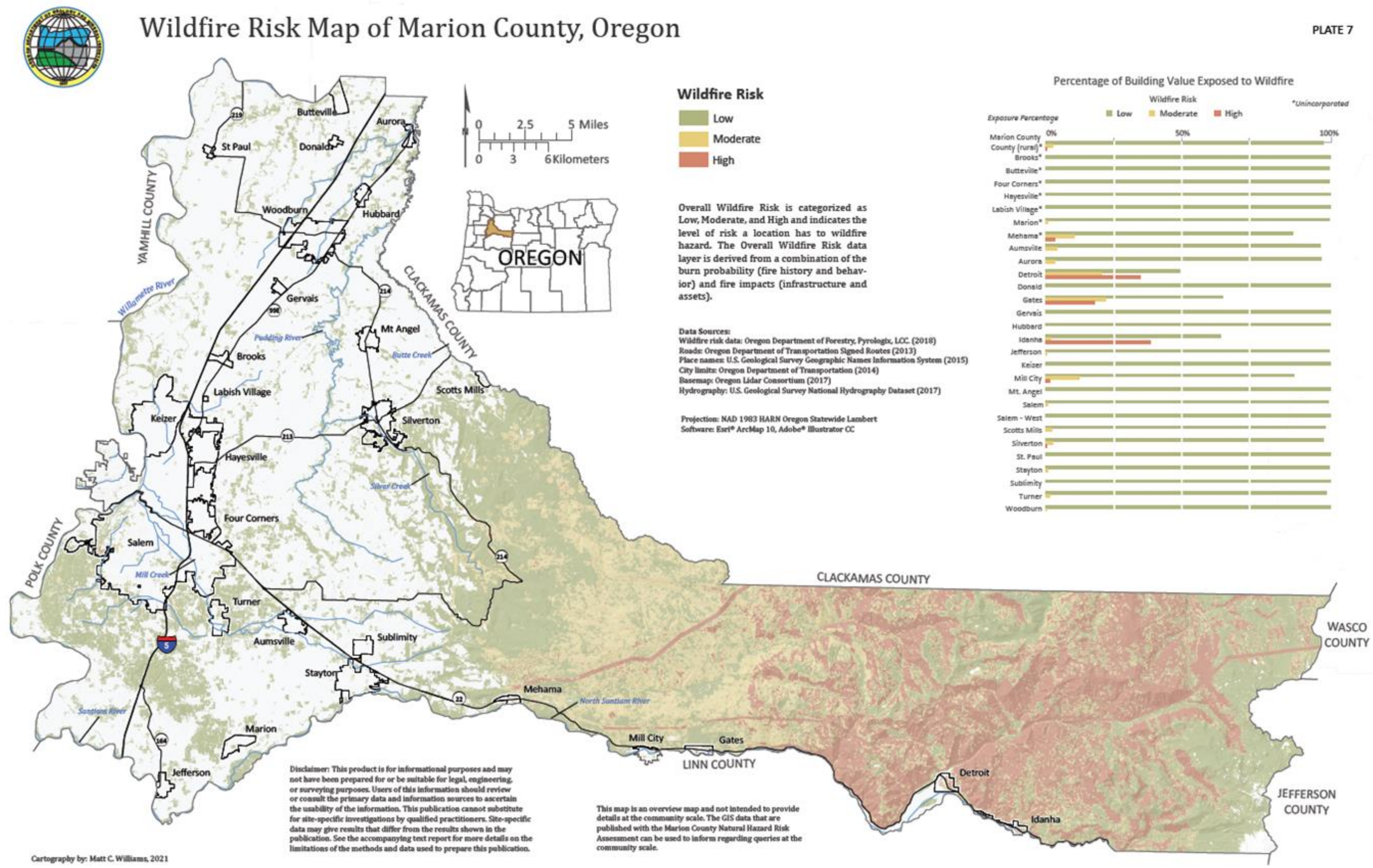
A fire storm is a very intense and destructive fire usually accompanied by high winds. As defined by NWCG, "Violent convection caused by a large continuous area of intense fire. Often characterized by destructively violent surface indrafts, near and beyond the perimeter, and sometimes by tornado-like whirl."

Figure 48 Wildland Interface Fire Risk Areas



Source: City of Salem

Figure 49 Wildfire Risk Map of Marion County, Oregon



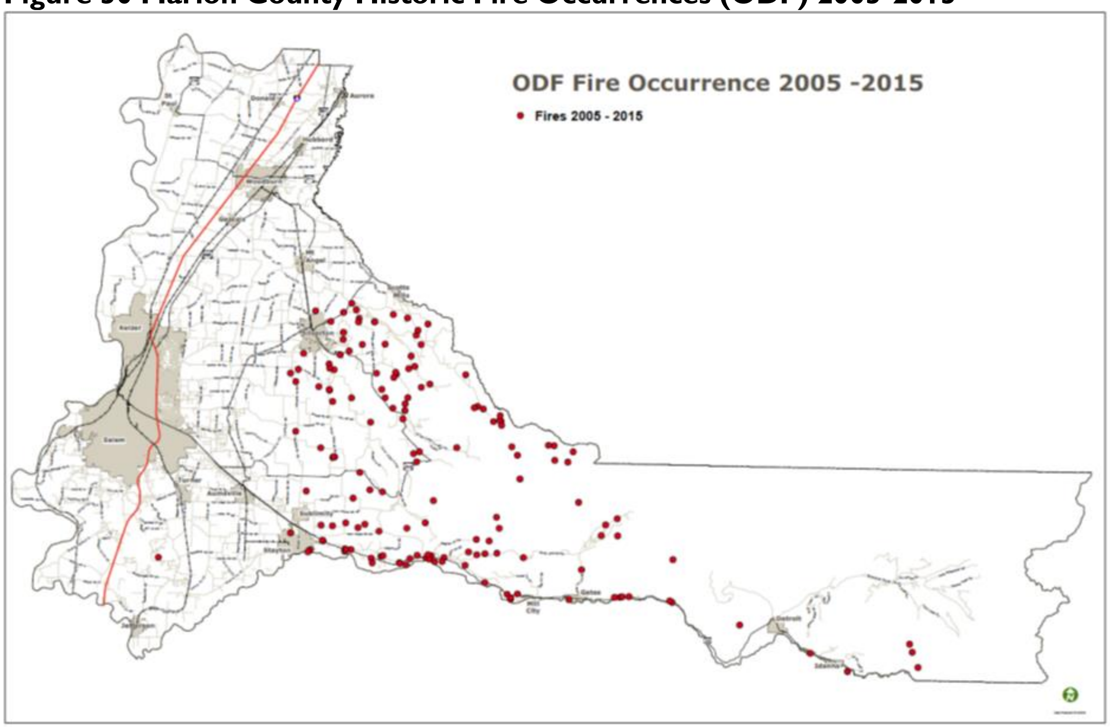
Source: Williams et al., 2022

History

Salem's climate, vegetation, and topography make wildland fire a rare but real risk to the community. Parts of the city have homes interspersed with large areas of natural vegetation. Many of these homes are located at the top of moderate to steep slopes, increasing the risk.

Historically, Salem experiences small, slow moving, wildland fires on a regular basis. Warm summer temperatures and strong winds can carry wildland fires into homes. However, fuel types found in this region do not support aggressive fire behavior. Salem has had relatively few occurrences of WUI Fire hazards that have resulted in minimal dollar losses. Refer to Figure 49 above that illustrates the WUI high risk areas in and near the city. Most fire incidents are human caused and include vegetation fires, forest/wood fires, brush and grass fires. In July 2014, a four-alarm grassfire just West of Salem caused at least two homes to be evacuated. The location of the grassfire was off Highway 22 between Doaks Ferry Road NW and College Drive NW. In July 2015, a 15-acre wildfire threatened 15-20 homes on SE Macleay Road between 74th and 78th avenues. One hundred firefighters responded to the fire and could contain the burn within about an hour. No damage to life or property was reported. Figure 51 shows the countywide wildfire history from 2005 to 2015 per the Marion County CWPP.

Figure 50 Marion County Historic Fire Occurrences (ODF) 2005-2015

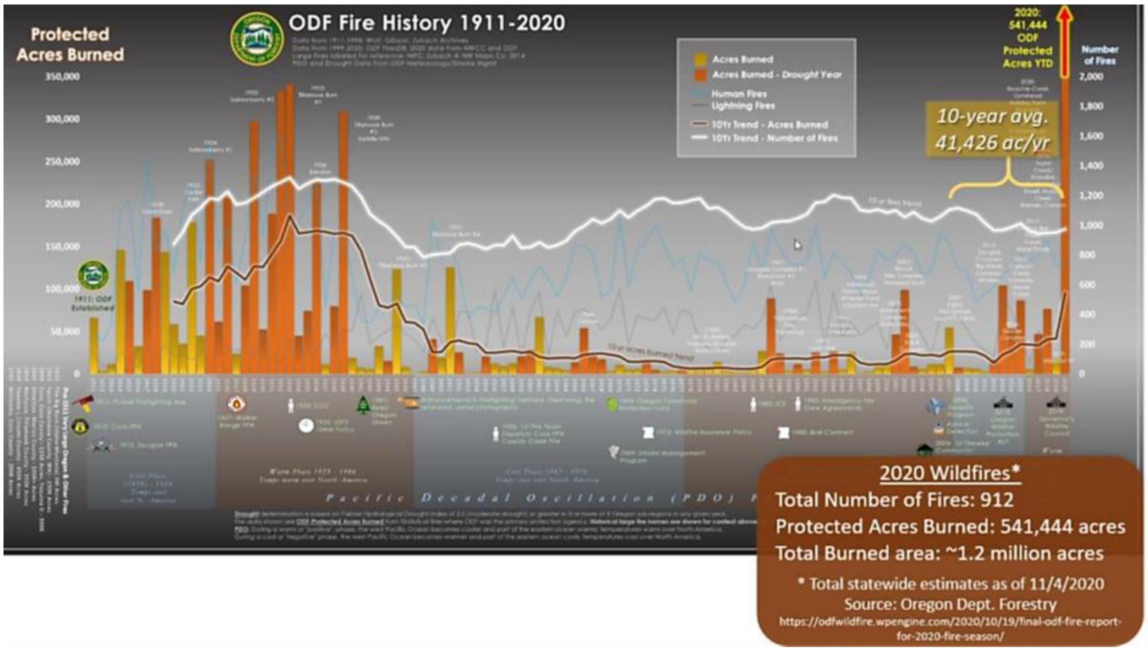


Source: Marion County, 2017

2020 Oregon Wildfire Season

During 2020, wildfires burned over 1.2 million acres in Oregon and destroyed 4,000 homes. Nine civilians and two firefighters lost their lives. 2020 was the most destructive wildfire season in Oregon in history. Figure 52 provides a visual of wildfire history from ODF with several statistics for 2020 highlighted.

Figure 51 Oregon Department of Forestry, Fire History 1911-2020



Source: Adair,2021

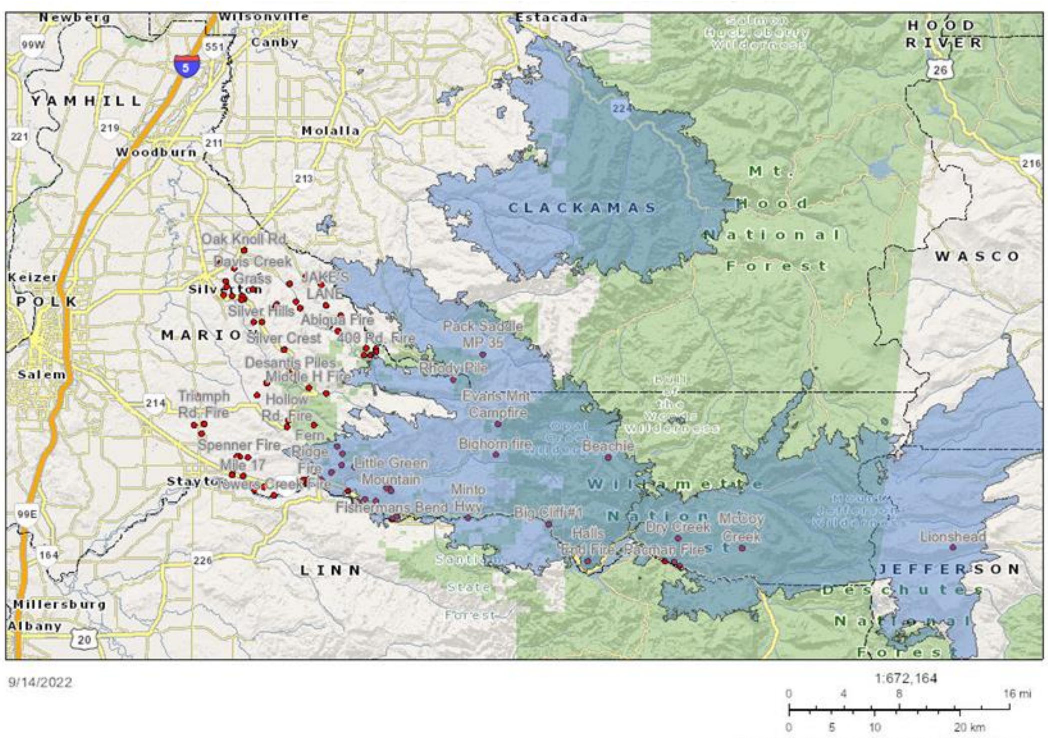
According to ODF's 2020 Fire Season document (Alcock, 2021), much of the state was in severe drought from spring onward. Numerous wildfires broke out in a very dry southern Oregon in April, leading Southwest Oregon to declare the start of fire season on May 1, which is a month earlier than usual. During the summer, human-caused wildfires were up slightly but fewer lightning-caused fires occurred until mid-August. In August, there were five days of lightning across the state. Fires started by those lightning strikes were fanned by winds and high temperatures into large blazes.

On August 19, 2020, Governor Brown declared a statewide State of Emergency. This made available the Oregon National Guard for firefighting, including personnel and equipment. On September 7, 2020, against a backdrop of drought and historically low fuel moistures and humidity, a high wind warning was issued. A strong cold front arrived in the early evening, with east-northeast winds at sustained speeds of 20 to 30 miles per hour (mph) and gusts to 50 to 60 mph. This was the strongest three-day easterly wind event during fire season since at least 1950 (winds were stronger in the 1962 Columbus Day storm, but that hit after fire season).

There were 14 fires from the Labor Day wind event that would be approved as a FEMA FMAG fire. Five fires in the Cascade Range soon spread west to become fire storms (over 100,000 acres), almost as many as occurred in Oregon in the entire 20th century. All five of these fires moved into Oregon's top 20 wildfires by size since 1900. Firefighting personnel and equipment poured into Oregon from more than 30 different U.S. states and Canada, peaking at about 7,500. The Labor Day wildfires were mostly contained by late September or October 2020.

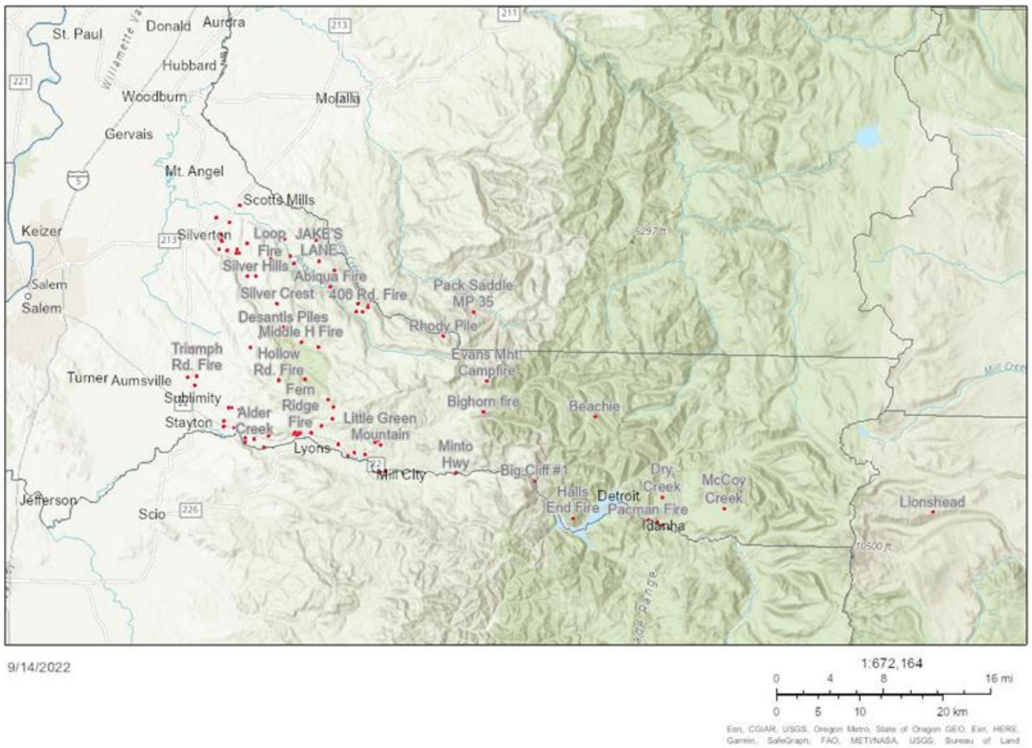
Of the 2020 Labor Day wildfires, Marion County was impacted by the Beachie Creek and Lionshead fires which merged in Marion County burning approximately 400,000 acres. In addition, the Riverside Fire burned in the northern part of the county. The Beachie Creek fire burned 193,565 acres of land in the counties of Linn, Marion and Clackamas including portions of the Mill City before it merged with the Lionshead fire. The Beachie Creek wildfire started on August 16, 2020, in the Opal Creek Wilderness in Marion County. The fire remained in a remote location through the month then grew rapidly in September because of the widespread wind gusts, noted above, of 50-70 miles per hour. The Strong winds caused widespread damage to trees, and downed numerous power lines across the region, which started at least 13 additional wildfires. Large portions of the cities of Detroit, Mehama, and Gates were destroyed, and significant portions of Idanha, Mill City, and Lyons also burned. The 2020 Labor Day wildfires burned a total of 1,000,000 acres (Wikipedia, 2022).

Figure 52 Marion County Wildfire Occurrences (2016-2021) and 2020 Wildfire Perimeters



Source: Oregon Department of Forestry, 2023

Figure 53 Marion County Cities and 2016-2021 Wildfire Occurrences



Source: Oregon Department of Forestry, 2023

Future Climate Variability

In the *2023 Salem NHMP*, there are several locations that describe future changing conditions or climate change as it relates to the natural hazards that impact Salem and to some extent, the surrounding areas. In the order of appearance in the NHMP, the Risk Assessment and the Hazards Annexes contain this information. Documents such as the DEQ *Oregon Air Quality Monitoring Annual Report: 2020* describe that with climate change we expect more fires in the Pacific Northwest and higher temperature days, resulting in more elevated ozone days.

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.

Based on the available data and research for Salem the NHMP Steering Committee determined the **probability of experiencing a wildfire is "high,"** meaning one incident is likely within the next 10 to 35-year period.

Vulnerability Assessment

Wildfires are a natural part of forest and grassland ecosystems. Past forest practices included the suppression of all forest and grassland fires. This practice, coupled with hundreds of acres of dry brush or trees weakened or killed through insect infestation, has fostered a dangerous situation. Present state and national forest practices include the reduction of understory vegetation through thinning and prescribed (controlled) burning.

Each year a significant number of people build homes within or on the edge of the forest (urban/wildland interface), thereby increasing wildfire hazards. Many Oregon communities (incorporated and unincorporated) are within or abut areas subject to serious wildfire hazards, complicating firefighting efforts and significantly increasing the cost of fire suppression.

Wildfires in the past have caused no personal injury or death. However, the potential for injuries or deaths from past events or from similar events in other communities could escalate resulting in multiple minor injuries or possible major injury. Salem estimates that less than 10% of the city's population could be physically displaced by a wildfire, considering the proximity of residential housing to WUI vulnerable areas; and there would be mild impact on community social networks. The west and south areas of the city are the most vulnerable, particularly the residential areas along Eola Ridge.

Multiple facilities throughout the city anticipate moderate damage due to wildfires, estimated at less than $1 million for hazard response, structural repairs and equipment replacement. In terms of commercial business, it is likely that less than 10% of businesses located in the city and surrounding area could experience commerce interruption for a period of hours. The businesses most impacted are those near WUI areas. Lastly, wildfires could likely have mild impacts on 10-25% of the city's ecological systems, including, clean water, wildlife habitat, and parks.

According to DOGAMI's *Multi-hazard Risk Report for Marion County, Oregon* (Williams et al., 2022), during a high and moderate risk scenario, there is the potential to have 1,555 (1.1%) displaced residents, 432 exposed buildings, none of which are critical facilities. Exposed building value of $170,463,265 (exposure ratio 0.8%).

Salem Climate Action Plan 2021

The *Salem Climate Action Plan 2021* outlines the following potential vulnerabilities and consequences of various projected climate changes as it relates to wildfire.

Projected Wildfire Risk

Increased temperatures and drier conditions will lead to increased fire risk in forested areas outside of Salem. However, those impacts to Salem include health risks due to poor air quality, increased emergency operations and evacuations, and reductions in revenue and employment in the tourism industry.

- Poor to hazardous air quality resulting from wildfires would greatly impact vulnerable populations—for example, people who are unsheltered, people who work outdoors, and people who live with chronic medical conditions such as asthma.

- Salem's drinking water source, the North Santiam River, could be degraded. Debris and chemicals in surface water following a fire could put additional pressure on water treatment facilities. The Geren Island water treatment plant could itself be at risk of wildfire.
- Oregon's population growth could lead to increased pressure to build housing in fire-prone zones, further exacerbating fire risk.
- Higher than expected population growth. If people choose to relocate from other areas with higher climate change risk, the population influx could strain existing resources, services, and contribute to housing-related issues.
- Fire-damaged forests and trails and poor air quality may reduce tourism and outdoor events in the area, resulting in economic impacts.

The Marion County CWPP (2017) identifies the City of Salem as a community with **moderate/low** WUI fire risk priority based on three risk factors: fire behavior, values, and infrastructure. West Salem is in Polk County and is included within Zone 2 of the Polk County CWPP (an area covering a large section of the county east of the coast mountains), which has a **high** overall risk rating.

As such, the NHMP Steering Committee rated the city as having a **"moderate" vulnerability to wildfire hazards**, meaning that 1 to 10% of the city's population or assets would be affected by a major disaster; this rating has not changed since the previous plan.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

Windstorm

Significant Changes Since Previous Plan:

The Windstorm Hazard section was reformatted and expanded with additional information since the previous plan.

Causes and Characteristics

Extreme winds occur throughout Oregon and can occur in summer and winter. A windstorm is generally a short duration event involving straight-line winds and/or gusts more than 50 mph. The most persistent high winds take place along the Oregon Coast and in the Columbia River Gorge, with the Columbia River Gorge being the most significant east-west gap in the Cascade Range between California and Canada. Extreme weather events, however, occur in all regions of Oregon, according to the 2020 Oregon NHMP. West winds generated from the Pacific Ocean are strongest along the coast and slow down inland due to the obstruction of the Oregon Coast Range. Prevailing winds in Oregon vary with the seasons. In summer, the most common wind directions are from the west or northwest; in winter, they are from the south and east. Local topography, however, plays a major role in affecting wind direction (Statesman Journal, 2002).

Types of Damaging Winds

The NOAA National Severe Storms Laboratory's *Severe Weather 101* site describes the following eight types of damaging winds.

Straight-line wind

Straight-line wind is a term used to define any thunderstorm wind that is not associated with rotation and is used mainly to differentiate from tornadic winds.

Downdraft

A downdraft is a small-scale column of air that rapidly sinks toward the ground.

Macroburst

A macroburst is an outward burst of strong winds at or near the surface with horizontal dimensions larger than 4 km (2.5 mi) and occurs when a strong downdraft reaches the surface. To visualize this process, imagine the way water comes out of a faucet and hits the bottom of a sink. The column of water is the downdraft and the outward spray at the bottom of the sink is the macroburst. Macroburst winds may begin over a smaller area and then spread out over a wider area, sometimes producing damage similar to a tornado. Although usually associated with thunderstorms, macrobursts can occur with showers too weak to produce thunder.

Microbrust

A microburst is a small, concentrated downburst that produces an outward burst of strong winds at or near the surface. Microbursts are small — less than 4 km across — and short-lived, lasting only five to 10 minutes, with maximum windspeeds sometimes exceeding 100 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.

Downburst

A downburst is the general term used to broadly describe macro and microbursts. Downburst is the general term for all localized strong wind events that are caused by a strong downdraft within a thunderstorm, while microburst simply refers to an especially small downburst that is less than 4 km across.

Gust Front

A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.

Derecho

Derecho is a widespread, long-lived windstorm that is associated with a band of rapidly moving showers or thunderstorms. A typical derecho consists of numerous microbursts, downbursts, and downburst clusters. By definition, if the wind damage swath extends more than 240 miles (about 400 kilometers) and includes wind gusts of at least 58 mph (93 km/h) or greater along most of its length, then the event may be classified as a derecho.

Haboob

A haboob is a wall of dust that is pushed out along the ground from a thunderstorm downdraft at high speeds.

Tornadoes

The NOAA National Severe Storms Laboratory's site, identifies tornadoes as the following:

> A tornado is a narrow, violently rotating column of air that extends from a thunderstorm to the ground. Because wind is invisible, it is hard to see a tornado unless it forms a condensation funnel made up of water droplets, dust and debris. Tornadoes can be among the most violent phenomena of all atmospheric storms we experience.

Although rare, tornados can and do occur in Oregon. Tornadoes are the most concentrated and violent storms produced by the earth's atmosphere. They are created by a vortex of rotating winds and strong vertical motion, which possess remarkable strength and cause widespread damage. Wind speeds more than 300 mph have been observed within tornadoes, and it is suspected that some tornado winds exceed 400 mph. The low pressure at the center of a tornado can destroy buildings and other structures.

Tornadoes are most common in the Midwest and are more infrequent and generally small west of the Rockies. Nonetheless, Oregon and other western states have experienced tornadoes on occasion, many of which have produced significant damage and occasionally injury or death. Oregon's tornadoes can be formed in association with large Pacific storms arriving from the west. Most of them, however, are caused by intense local thunderstorms. These storms also produce lightning, hail, and heavy rain, and are more common during the warm season from April to October (Taylor et al., 1996).

Table 17 Estimating Wind Speeds with Visual Clues

Estimating Wind Speeds with Visual Clues			
Beaufort number	Description	Speed	Visual Clues and Damage Effects
0	Calm	Calm	Calm wind. Smoke rises vertically with little if any drift.
1	Light Air	1 to 3 mph	Direction of wind shown by smoke drift, not by wind vanes. Little if any movement with flags. Wind barely moves tree leaves.
2	Light Breeze	4 to 7 mph	Wind felt on face. Leaves rustle and small twigs move. Ordinary wind vanes move.
3	Gentle Breeze	8 to 12 mph	Leaves and small twigs in constant motion. Wind blows up dry leaves from the ground. Flags are extended out.
4	Moderate Breeze	13 to 18 mph	Wind moves small branches. Wind raises dust and loose paper from the ground and drives them along.
5	Fresh Breeze	19 to 24 mph	Large branches and small trees in leaf begin to sway. Crested wavelets form on inland lakes and large rivers.
6	Strong Breeze	25 to 31 mph	Large brances in continous motion. Whistling sounds heard in overhead or nearby power and telephone lines. Umbrellas used with difficulty.
7	Near Gale	32 to 38 mph	Whole trees in motion. Inconvenience felt when walking against the wind.
8	Gale	39 to 46 mph	Wind breaks twigs and small branches. Wind generally impedes walking.
9	Strong Gale	47 to 54 mph	Structural damage occurs, such as chimney covers, roofing tiles blown off, and television antennas damaged. Ground is littered with many small twigs and broken branches.
10	Whole Gale	55 to 63 mph	Considerable structural damage occurs, especially on roofs. Small trees may be blown over and uprooted.
11	Storm Force	64 to 75 mph	Widespread damage occurs. Larger trees blown over and uprooted.
12	Hurricane Force	over 75 mph	Severe and extensive damage. Roofs can be peeled off. Windows broken. Trees uprooted. RVs and small mobile homes overturned. Moving automobiles can be pushed off the roadways.

Source: National Weather Service Weather Forecast Office Portland, OR

Location and Extent

The most common type of wind pattern affecting Salem 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. For Salem, the wind hazard levels are generally highest near the Willamette River and then uniform across most of the rest of the city. 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.

Although windstorms can affect the entirety of the city, 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 trees and power lines, damage homes, businesses, public facilities, and create tons of storm related debris.

Identifying Windstorms

Windstorms in Salem and Marion County can occur in summer and winter; they usually occur from October to March. Their extent is determined by their track, intensity (the air pressure gradient they generate), and local terrain. The NOAA National Severe Storms Laboratory uses weather forecast models to predict oncoming windstorms, while monitoring storms with weather stations in protected valley locations throughout Oregon. Thunderstorms can bring high winds during the warmer months, April to October. Tornadoes are the most violent of windstorms and are occasionally caused by intense local thunderstorms, which are more common during the warm season.

Detection of Damaging Winds

According to the NOAA National Severe Storms Laboratory, severe and damaging wind events are difficult to forecast because any type of thunderstorm – even one that is dying – can produce them. The National Severe Storms Laboratory states,

> Doppler radar velocity data can show areas of diverging winds at the surface, and even the strength of those winds, indicating a downburst.
>
> Winds coming together at midlevels of the storm, known as convergence, can also be seen on velocity displays and can indicate the development of a downburst. One of the challenges in the severe storm warning process is forecasting the initial onset of damaging winds.

With the doppler radar, meteorologists look for signals in mid and upper levels of thunderstorms. They also look for signals in the environment surrounding the storms, and the behavior of storms. In addition, forecasters must also study the existing atmospheric environment and look for the amounts of dry air, moist air, strength of the updraft, and storm motion.

Detection of Tornadoes

According to the NOAA National Severe Storms Laboratory, when trying to identify a tornado, storm spotters look for a variety of characteristics. These characteristics include inflow bands, beaver's tail, wall cloud, rear flank downdraft, and condensation funnel. In addition, the strength of a tornado is determined by examining the damage caused, which can then estimate wind speed.

For more information on these tornado characteristics, visit NOAA National Severe Storms Laboratory's site https://www.nssl.noaa.gov/education/svrwx101/tornadoes/.

There are two types of tornado warnings – Tornado Watch and Tornado Warning. A Tornado Watch is issued by the NOAA Storm Prediction Center whose meteorologist watch the weather across the U.S. for conditions that are favorable for tornadoes and severe weather. A Tornado Watch can cover parts of one state or several states.

A Tornado Warning is issued by NOAA National Severe Storms Laboratory local forecast office, whose meteorologist watch the weather in a designated area. This means that storm spotters have reported a tornado or radar indicates, "there is a serious threat to life and property to those in the path of the tornado." A Tornado Warning can cover parts of counties or several counties.

History

In 2009, just outside of Salem on Highway 22, winds and a thunderstorm brought down several trees. In January 2012, severe winds accompanied a winter storm with gusts measuring 59 knots a causing multiple power outages (FEMA-4055-DR-OR). In March/April of 2012 Severe winds and storm conditions impacted a large multi-county region of Western Oregon, with considerable damage sustained in Salem. Disaster response efforts focused on debris removal, repair of heavily wooded transmission line, and restoration of flood-damaged structures. In March 2015, strong winds were measured at the Salem airport.

The most significant recent storm occurred in December of 2010 culminating in an EF2 tornado touching down in the City of Aumsville (17 miles SE of Salem) with wind speeds between 110 and 120 mph. This was the largest tornado recorded in Marion County to date and the second largest in the state since 1950. According to a December 23, 2010, NOAA storm survey report, the tornado traveled in a northeasterly direction and had a path length of approximately five-miles. The initial damage assessment estimated total losses at over $1.1 million (Marion County, 2010).

Windstorms occur yearly; more destructive storms occur once or twice per decade. The *Columbus Day Storm*, October 1962, was Oregon's most destructive storm to date with winds approaching 116 mph winds in Willamette Valley. An estimated 84 houses were destroyed, with 5,000 severely damaged and with a total damage estimate of $170 million. Recent storms occurred in January 2012 *(FEMA-4055-DR-OR),* February 2014 *(FEMA-4169-DR-OR), and December 2015 (FEMA-4258-DR-OR).*

Several additional, small windstorm events have occurred since the previous plan, see the Storm Events Database provided by the NOAA for more information.

All of Salem is susceptible to severe windstorms. Table 18 includes a list of windstorms and tornadoes that have occurred in Marion and Polk Counties between 2017-2022.

Table 18 Windstorm Events in Marion and Polk Counties 2017-2022

Zone	Begin Date	Begin Time	Event Type	Deaths
MARION COUNTY	10/12/2017	1200	Tornado	0
NORTH OREGON CASCADES FOOTHILLS (ZONE)	3/8/2018	800	Strong Wind	0
NORTH OREGON CASCADES FOOTHILLS (ZONE)	4/7/2018	1300	High Wind	0
MARION COUNTY	10/29/2018	1430	Tornado	0
MARION COUNTY	12/1/2018	1430	Funnel Cloud	0
CENTRAL WILLAMETTE VALLEY (ZONE)	12/18/2018	--	Strong Wind	0
CENTRAL WILLAMETTE VALLEY (ZONE)	1/5/2019	2025	Strong Wind	0
NORTH OREGON CASCADES FOOTHILLS (ZONE)	9/7/2020	1906	High Wind	0
NORTH OREGON CASCADES (ZONE)	9/7/2020	1906	High Wind	0
MARION COUNTY	9/17/2020	15	Thunderstorm Wind	0
MARION COUNTY	9/18/2020	15	Thunderstorm Wind	0
CENTRAL WILLAMETTE VALLEY (ZONE)	1/12/2021	2236	Strong Wind	0
POLK COUNTY	1/12/2021	2312	Thunderstorm Wind	0
CENTRAL WILLAMETTE VALLEY (ZONE)	5/22/2021	1335	Strong Wind	0
CENTRAL WILLAMETTE VALLEY (ZONE)	11/4/2021	850	Strong Wind	0
CENTRAL WILLAMETTE VALLEY (ZONE)	12/11/2021	600	High Wind	0
MARION COUNTY	3/28/2022	1200	Funnel Cloud	0
CENTRAL WILLAMETTE VALLEY (ZONE)	5/28/2022	1600	Strong Wind	0

Source: National Oceanic and Atmospheric Administration
Note: The bolded Central Willamette Valley (Zone) events were windstorm that affected Salem and the surrounding areas.

Future Climate Variability

In the *2023 Salem NHMP*, there are several locations that describe future changing conditions or climate change as it relates to the natural hazards that impact Salem and the surrounding area. In the order of appearance in the NHMP it is in the Risk Assessment and the Hazard Characterizations.

Refer to the 2020 Oregon NHMP for climate change information about the Mid/Southern Willamette Valley Region (Region 3). Region 3 includes Linn, Lane (non-coastal), Marion, Polk, and Yamhill Counties. The hazards faced by Region 3 that are projected to be influenced by climate change include drought, wildfire, flooding, landslides, and extreme heat. The *2020 Oregon Natural Hazards Mitigation Plan* also states,

> There is insufficient research on changes in the likelihood of windstorms in the Pacific Northwest as a result of climate change. While climate change has the potential to alter surface winds through changes in the large-scale free atmospheric circulation and storm systems, there is as yet no consensus on whether or not extratropical storms and associated extreme winds will intensify or become more frequent along the Pacific Northwest coast under a warmer climate.

Probability Assessment

Windstorms in Salem 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, while monitoring storms with weather stations in protected valley locations throughout Oregon.

Table 19 shows the wind speed probability intervals that structures 33 feet above the ground would expect to be exposed to within a 25, 50 and 100-year period. The 100-year event for a windstorm in Region 3 is 1-minute average winds of 75 mph. A 50-year event has average winds of 68 mph. A 25-year event has average winds speeds of 60 mph.

Table 19 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 Department of Land Conservation and Development,

Based on the available data and research for Salem the NHMP Steering Committee determined the **probability of experiencing a windstorm is "high,"** meaning one incident is likely within the next 35-year period.

Vulnerability Assessment

Many buildings, utilities, and transportation systems within Salem 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 high winds 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, up rooted or shattered trees can down power and/or utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. In Salem, trees are more likely to blow over during the winter (wet season).

Windstorms in the past caused multiple minor injuries or a major injury. However, the potential for injuries or deaths from past events or from similar events in other communities could escalate resulting in multiple major injuries or possible death. Salem estimates that more than 10% of the city's population could be physically displaced by a windstorm, accounting for the number of homes that loose power or properties with downed trees; and there would be mild impact on community social networks.

Several facilities throughout the city anticipate mild damage due to a windstorm, estimated between $1 million and $10 million for hazard response, structural repairs and equipment replacement. In terms of commercial business, it is likely 10-30% of businesses located in the city and surrounding area could experience commerce interruption for a period of a days. Windstorms have the potential to inflict widespread power outages and until power can be restored, business may experience interruption. Lastly, windstorms would likely have extensive impacts on more than 75% of the city's ecological systems, including, clean water, wildlife habitat, and parks.

As such, the NHMP Steering Committee rated the city as having a **"moderate" vulnerability to windstorm hazards**, meaning that between 1 to 10% of the city's population or assets would be affected by a major disaster.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are highlighted in the Mitigation Strategy (Volume I: Section 3).

Winter Storm

Significant Changes Since Previous Plan:

The Winter Storm Hazard section was reformatted and expanded with additional information since the previous plan.

Causes and Characteristics

Winter storms affecting Salem are generally characterized by a combination of heavy rains and high winds throughout the city, sometimes with snowfall, especially at higher elevations. Heavy rains can result in localized or widespread flooding, as well as debris slides and landslides. High winds commonly result in tree falls which primarily affect the electric power system, but which may also affect roads, buildings and vehicles. This chapter deals primarily with the snow and ice effects of winter storms.

The winter storms that affect Salem are typically not local events affecting only small geographic areas. Rather, the 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.

Three basic ingredients are necessary to make a winter storm, according to NOAA National Severe Storms Laboratory:

Cold air. Below freezing temperatures in the clouds and near the ground are necessary to make snow and/or ice.

Lift. Something to raise the moist air to form the clouds and cause precipitation. An example of lift is warm air colliding with cold air and being forced to rise over the cold dome. The boundary between the warm and cold air masses is called a front. Another example of lift is air flowing up a mountainside.

Moisture. To form clouds and precipitation. Air blowing across a body of water, such as a large lake or the ocean, is an excellent source of moisture.

With the three basic ingredients necessary to have a winter storm, there are then three types of winter precipitation that can be created, which include snow, sleet, and freezing rain.

Types of Winter Storms

The principal types of winter storms that occur include the following:

Snowstorms

Snowstorms require three ingredients of 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.

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.

Ice storms

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). Of these, freezing rain can be the most damaging of ice formations. An ice storm is significant with ice accumulations of 0.25 inches or greater, according to FEMA's National Risk Index.

Extreme Cold

Dangerously low temperatures accompany many winter storms. This is particularly dangerous because snow and ice storms can cause power outages, leaving many people without adequate heating.

Location and Extent

Ice storms occasionally occur in northern areas of Oregon, resulting from cold air flowing westward through the Columbia Gorge. Freezing rain can be the most damaging of ice formations. 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 Columbia 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. Salem is located within Zone 2: Willamette Valley (Figure 54). The climate in Zone 2 generally consists of cool, wet winters and warm, dry summers, according to Oregon Climate Service. These wet winters result in potentially destructive winter storms that produce heavy snow, ice, rain and freezing rain, and high winds.

Figure 54 Oregon Climate Divisions

Source: Oregon Climate Service

Unlike most other hazards, it is not simple to systematically map winter storm hazard zones. The entire city is susceptible to damaging severe weather. Winter storms that bring snow and ice can impact infrastructure, business, and individuals. Those resources that exist at higher elevations will experience more risk of snow and ice, but the entire city can face damage from winter storms and, for example, the hail or life threateningly cold temperatures that winter storms bring.

Identifying Winter Storms

The magnitude or severity of severe winter storms is determined by several meteorological factors including the amount and extent of snow or ice, air temperature, wind speed, and event duration. Precipitation, an additional element of severe winter storms, is measured by gauging stations. The National Weather Service monitors the stations and provides public warnings on storm, snow, and ice events as appropriate.

Detection of Winter Storms

According to the NOAA National Severe Storms Laboratory, winter weather and storms use a variety of tools to forecast winter weather and storms.

As identified on NOAA National Severe Storms Laboratory's *Severe Weather 101* site, these tools are the following:

Satellite images are very useful tools for determining cloud patterns and movement of winter storms. By looping a series of satellite pictures together, forecasters can watch a storm's development and movement.

Radar is critical for tracking the motion of precipitation and for determining what kind of precipitation is falling.

The **NWS's dual-polarized radars** send electromagnetic wave fields at a 45-degree angle, rather than just horizontally. As these angled fields bounce off an object and are received back at the radar, a computer program separates the fields into horizontal and vertical information. This 2-D snapshot now gives forecasters a measure of the size and shape of the object. With this information, forecasters can clearly identify rain, hail, snow, ice pellets and even bugs. If they know what type of precipitation is falling, they will make more accurate estimates of how much to expect.

Doppler radar can show the wind direction too, which is helpful when forecasting near mountains and large bodies of water.

If the radar shows wind blowing up the mountain (upslope), forecasters know that automatically, one of the ingredients is in place of the development of precipitation: lift. If the radar shows wind blowing over a large section of a body of water (fetch), then they know that another ingredient is present for the formation of precipitation – moisture.

Radar velocities can help identify the location of cold fronts because there is usually a sharp change in wind direction and will show up as a on Doppler radar.

In addition to observing a wide network of satellites, Doppler radars and automated surface observing systems, forecasters use their experience, together with computer forecast models to write and issue forecasts on what will happen next.

There are various winter weather notices. The following is a list from NOAA National Severe Storms Laboratory's *Severe Weather 101* site.

Blizzard Warning: Issued when winds of 35 mph or greater are combined with blowing and drifting snow with visibilities of ¼ mile or less. Seek indoor shelter immediately and stay indoors until the severe conditions end.

Winter Storm Warning: Issued when a combination of hazardous winter weather in the form of heavy snow, heavy freezing rain, or heavy sleet is imminent or occurring. Winter Storm Warnings are usually issued 12 to 24 hours before the event is expected to begin.

Winter Storm Watch: Issued 12-48 hours in advance of the onset of severe winter conditions. The watch may or may not be upgraded to a winter storm warning, depending on how the weather system moves or how it is developing.

Winter Storm Outlook: Issued prior to a Winter Storm Watch. The Outlook is given when forecasters believe winter storm conditions are possible and are usually issued 3 to 5 days in advance of a winter storm.

Winter Weather Advisories: Issued for accumulations of snow, freezing rain, freezing drizzle, and sleet which will cause significant inconveniences and, if caution is not exercised, could lead to life-threatening situations.

Lake Effect Snow Warning: Issued when heavy lake effect snow is imminent or occurring.

Lake Effect Snow Advisory: Issued when accumulation of lake effect snow will cause significant inconvenience.

Wind Chill Warning: Issued when wind chill temperatures are expected to be hazardous to life within several minutes of exposure.

Wind Chill Advisory: Issued for a wind chill situation that could cause significant inconveniences, but do not meet warning criteria. Criteria for issuing Windchill Warnings and Advisories are set locally.

Dense Fog Advisory: Issued when fog will reduce visibility to ¼ mile or less over a widespread area.

Snow Flurries: Light snow falling for short durations. No accumulation or light dusting is all that is expected.

Snow Showers: Snow falling at varying intensities for brief periods of time. Some accumulation is possible.

Blowing Snow: Wind-driven snow that reduces visibility and causes significant drifting. Blowing snow may be snow that is falling and/or loose snow on the ground picked up by the wind.

History

All of Salem is susceptible to winter storms, which can occur yearly; more destructive storms occur once or twice per decade. According to FEMA's Disaster Declarations for States and Counties, several additional, winter storm events have occurred since the previous plan, including in February 2016 (FEMA-4258-DR-OR) and February 2021(FEMA-4599-DR-OR). Other occurrences include in early 2008, Over several weeks, the foothills of the Cascades received unusually high amounts of snow from a series of storms. Towns east of Salem, including Idanha and Detroit, were buried by 12-feet of snow over these two months. Several local agencies from Marion and Linn Counties, and the City of Salem were sent to assist these communities. Three dozen National Guard soldiers, along with snow removal equipment, inmate crews, and engineers, were sent by the State into the towns to remove snow and help those in need (Salem-News.com, 2008).

Another prolonged snowstorm hit the region during the 2008-2009 winter season. According to NWS, Salem received over a foot of snow and the Portland airport received a record 18.9 inches. (*Some of the Area's Snowstorms*). This snowstorm resulted in landslides and mudslides and warranted a Presidential Disaster Declaration on March 2, 2009, according to FEMA (DR-1824-OR). According to FEMA's DR-1824-OR declaration, ten Oregon counties were included in this disaster declaration, including Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties. In March of 2012, Salem experienced a relatively unusually late snowfall across the Willamette Valley. Salem received two to seven inches of snow, with the highest amounts on the hill in South Salem. This was the biggest snowstorm to strike Salem this late in the winter season. On average Salem receives 0.3 inches of snow in March. Other recorded late snowfalls occurred in March of 1951 totaling 9.6 inches and March of 1960, where Salem received 8.5 inches, according to the National Weather Service.

More recently, in February 2021, a major, widespread, multi-faceted winter storm that caused major problems across the northern Willamette Valley especially in the lowlands. Impacts were felt as far south as Albany. The Portland area had measured 10.1 inches of snow, followed by roughly 0.75 inches of ice. Significant impacts to infrastructure occurred, with over 400,000 people losing power at some point during the storm. The area impacted the hardest appears to be the southern portions of the Portland metro area from Oregon City and Silverton and as far south as Salem and Aumsville. Polk County was hit hard by ice as well, with 1.00 to 1.75 inches of ice reported. Some people in these areas hard-hit by ice lost power for over a week.

This was mostly an ice event for the Central Willamette Valley as a major ice storm occurred from freezing rain. By the end of the event, there were many reports of over 1 inch of ice accumulation, with as much as 1.75 inch reported in Sheridan. This was a crippling ice storm for the Salem metro area where generally amounts of 0.5 to 1.25 inches of ice were reported, and many were without power for days. Key impacts include widespread tree damage and power outages, including 110,000 customers without power in Salem. Multiple road closures as well including Highway 99.

Additional winter storm events are identified in Table 20 for all of Marion and Polk Counties between 2017-2022.

Table 20 Winter Storm Events in Marion and Polk Counties 2017-2022

Zone	Begin Date	Begin Time	Event Type	Deaths
NORTH OREGON CASCADES (ZONE)	10/12/2017	1400	Heavy Snow	0
NORTH OREGON CASCADES FOOTHILLS (ZONE)	2/20/2018	900	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	2/25/2018	700	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	4/7/2018	1700	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	12/11/2018	1400	Winter Weather	0
NORTH OREGON CASCADES FOOTHILLS (ZONE)	2/8/2019	2000	Heavy Snow	0
NORTH OREGON CASCADES (ZONE) NORTH OREGON CASCADES FOOTHILLS (ZONE)	2/10/2019	1900	Heavy Snow	0
NORTH OREGON CASCADES (ZONE) NORTH OREGON CASCADES FOOTHILLS (ZONE)	2/23/2019	1600	Heavy Snow	0
NORTH OREGON CASCADES (ZONE) NORTH OREGON CASCADES FOOTHILLS (ZONE)	2/24/2019	1600	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	11/26/2019	1200	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	1/10/2020	1100	Heavy Snow	0
NORTH OREGON CASCADES FOOTHILLS (ZONE)	1/13/2020	500	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	3/30/2020	2312	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	11/13/2020	100	Heavy Snow	0

Zone	Begin Date	Begin Time	Event Type	Deaths
CENTRAL WILLAMETTE VALLEY (ZONE)	1/26/2021	1300	Winter Weather	0
CENTRAL WILLAMETTE VALLEY (ZONE)	2/11/2021	1400	Ice Storm	0
NORTH OREGON CASCADES (ZONE) NORTH OREGON CASCADES FOOTHILLS (ZONE)	2/11/2021	1600	Winter Storm	0
NORTH OREGON CASCADES (ZONE)	2/25/2021	700	Winter Storm	0
NORTH OREGON CASCADES (ZONE)	12/11/2021	300	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	12/19/2021	700	Heavy Snow	0
NORTH OREGON CASCADES (ZONE) NORTH OREGON CASCADES FOOTHILLS (ZONE)	12/24/2021	500	Heavy Snow	0
CENTRAL WILLAMETTE VALLEY (ZONE)	12/25/2021	1600	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	1/2/2021	2100	Heavy Snow	0
NORTH OREGON CASCADES FOOTHILLS (ZONE)	1/3/2021	300	Heavy Snow	0
NORTH OREGON CASCADES (ZONE)	4/3/2022	2300	Winter Storm	0
NORTH OREGON CASCADES (ZONE) NORTH OREGON CASCADES FOOTHILLS (ZONE)	4/10/2022	1900	Winter Storm	0

Source: National Oceanic and Atmospheric Administration.
Note: This table does not include those storms that occurred in the Central Coast Range of W Oregon Zone. The bolded Central Willamette Valley (Zone) events were winter storms affected Salem and the surrounding areas.

Future Climate Variability

In the *2023 Salem NHMP*, there are several locations that describe future changing conditions or climate change as it relates to the natural hazards that impact Salem and the surrounding area. In the order of appearance in the NHMP it is in the Risk Assessment and the Hazard Characterizations.

Refer to the 2020 Oregon NHMP for climate change information about the Mid/Southern Willamette Valley Region (Region 3). Region 3 includes Linn, Lane (non-coastal), Marion, Polk, and Yamhill Counties. The hazards faced by Region 3 that are projected to be influenced by climate change include drought, wildfire, flooding, landslides, and extreme heat. The 2020 Oregon NHMP also states, “There is no current research available about changes in the incidence of winter storms in Oregon due to changing climate conditions. However, the warming climate will result in less frequent extreme cold events and high-snowfall years.”

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. Salem experiences winter storms a couple times every year, to every other year.

Based on the available data and research for Salem the NHMP Steering Committee determined the **probability of experiencing a winter storm is "high,"** meaning one incident is likely within the next 35-year period.

Vulnerability Assessment

Given current available data, no quantitative assessment of the risk of winter storm was possible at the time of this NHMP update. However, assessing the risk to Salem from winter storms should remain an ongoing process determined by community characteristics and physical vulnerabilities. Weather forecasting can give city resources (emergency vehicles, warming shelters) time to prepare for an impending storm, but the changing character of the city population and resources will determine the impact of winter storms on life and property in Salem.

The most likely Impact of snow and ice events on Salem 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.

Winter storms which bring snow, ice and high winds can cause significant impacts on life and property. Many severe winter storm deaths occur because of traffic accidents on icy roads, heart attacks may occur from exertion while shoveling snow, and hypothermia 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.

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

Severe winter weather also can cause the temporary closure of key roads and highways, air and train operations, businesses, schools, government offices and other important community services. Below freezing temperatures can also lead to breaks in un-insulated water lines serving schools, businesses, industries, and individual homes. All these effects, if lasting more than several days, can create significant economic impacts for the affected communities, surrounding region, and region. In the rural areas of Oregon severe winter storms can isolate small communities, farms, and ranches.

At the time of this update, sufficient data was not available to determine winter storm vulnerability in terms of explicit types and numbers of existing and future buildings, infrastructure, or critical infrastructure.

Winter storms in the past caused multiple major injuries or death. The potential for future injuries or deaths is anticipated to remain similar to historic events. Salem estimates that less than 10% of the City's population could be physically displaced by a winter storm, accounting for families that may not have access to warm shelter; and there would be moderate impact on community social networks due to poor driving conditions.

Several facilities throughout Salem anticipate mild damage due to winter storms, estimated at less than $1 million for hazard response, structural repairs and equipment replacement. In terms of commercial business, it is likely that more than 75% of businesses located in Salem and surrounding area could experience commerce interruption for a period of days until driving conditions improve. Winter storms will likely have the greatest impacts on the transportation system, as snow and ice can cause dangerous driving conditions. Lastly, winter storms could likely have extensive impacts on more than 75% of the City's ecological systems, including, clean water, wildlife habitat, and parks.

As such, the NHMP Steering Committee rated the city as having a **"high" vulnerability to winter storm hazards**, meaning that greater than 10% of the city's population or assets would be affected by a major disaster.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations.

Driving in Oregon's winters can be challenging. Using traction tires or traction devices can be more effective than all-weather tires on icy or snowy roads. Traction tires are studded tires, retractable studded tires, or other tires that meet the tire industry definition as suitable for use in severe snow conditions. Studded tires can be used in Oregon from November 1 to March 31. Research shows that traction tires are more effective than all-weather tires on icy roads or in severe snowy conditions but can be less effective in most other conditions. Traction devices such as chains or chain-like devices can be more effective than studded tires. Winter storm hazard is similar to windstorm in terms of strategies and programs at the state level. Mitigation activities and resources related to the Winter Storm hazard are highlighted in the Mitigation Strategy (Volume I: Section 3).

Community Vulnerability Identification and Assessment

Vulnerability assessment is the second phase of this Risk Assessment. Vulnerability assessment endeavors to identify important community assets and system vulnerabilities. Vulnerabilities include both physical assets such as businesses, homes, roads and critical infrastructure like drinking water sources, and public service and health service establishments as well as community assets including people, historic places, and environmental assets. The bases for updates to this phase of the Risk Assessment are the Hazard Vulnerability Assessment ranking exercise and research results of demographic and economic sources.

The Steering Committee engaged in a Hazard Vulnerability Assessment exercise based on the OEM methodology to identify the relative vulnerability of the City of Salem is to the hazards identified in phase one of the Risk Assessment and to describe the aspects of the community that are most at risk. A description of this HVA exercise and its results are contained in the Hazard Vulnerability Assessment section.

DOGAMI mapping also informs the assessment of vulnerability by illustrating the dispersed nature of rural residential structures. As part of DOGAMI's Risk Report for Marion County, including the City of Salem in both Marion and Polk Counties, analysts mapped building location and type, as well as population density. This mapping forms part of the full report analyzing the exposure of people and property and their susceptibility to four of the identified hazards (Flood, Earthquake, Wildfire and Volcanic Events) by overlaying high hazard areas with existing structures and populations.

Hazard Vulnerability Assessment

Hazard Vulnerability Assessment Methodology

The hazard vulnerability assessment methodology in Oregon (primarily to inform Emergency Operations Planning) was first developed by FEMA circa 1983, and gradually refined by OEM over the years.

The methodology produces scores that range 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%. We include the hazard analysis summary here to ensure consistency between the EOP and NHMP.

The Oregon method provides the jurisdiction with a sense of hazard priorities, or relative risk. It doesn't 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.

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 demonstrated below.

<u>History</u> (Weight Factor = 2)

History is the record of previous occurrences. Events to include in assessing history of a hazard 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

The HVA exercise was conducted during the November 15, 2022 and December 14, 2022 Steering Committee meetings to rank these hazards using the OEM methodology. Table 26 below displays the ranking of each of these hazards according to the group present at these meetings.

Hazard Vulnerability Assessment Matrix

The hazard vulnerability assessment matrix involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous sections), and (2) the likelihood or probability of the harm occurring. The methodology for the hazard analysis was first developed by FEMA and refined by the OEM, which is discussed above.

Table 21 presents the entire updated hazard analysis matrix for Salem. 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, probability or likelihood of a hazard event occurring, vulnerability to the community, and maximum threat or worst-case scenario, the Salem Steering Committee ranked extreme heat, air quality, and winter storm events as the top hazard threats to the city. Earthquake, flood, wildfire, and water quality rank in the upper middle tier. Drought and windstorm events rank in the lower middle tier. Landslide and volcano events comprise the lowest ranked hazards in the city. Other hazards such as hazardous materials incident event was not reviewed.

Table 21 City of Salem 2022/2023 Natural Hazard Vulnerability Assessment

HAZARD	HISTORY WF = 2	PROBABILITY WF = 7	VULNERABILITY WF = 5	MAX THREAT WF = 10	RISK SCORE	RISK LEVEL H-M-L
Extreme Heat	2 x 10 = 20	7 x 10 = 70	5 x 10 = 50	10 x 10 = 100	240	High
Air Quality	2 x 9 = 18	7 x 10 = 70	5 x 9 = 45	10 x 10 = 100	233	High
Winter Storm	2 x 9 = 18	7 x 10 = 70	5 x 9 = 45	10 x 10 = 100	233	High
Earthquake	2 x 3 = 6	7 x 9 = 63	5 x 8 = 40	10 x 10 = 100	209	Medium/ High
Flood	2 x 10 = 20	7 x 10 = 70	5 x 5 = 25	10 x 9 = 90	205	Medium/ High
Wildfire	2 x 9 = 18	7 x 10 = 70	5 x 5 = 25	10 x 9 = 90	203	Medium/ High
Water Quality	2 x 6 = 12	7 x 9 = 63	5 x 7 = 35	10 x 9 = 90	200	Medium/ High
Drought	2 x 4 = 8	7 x 9 = 63	5 x 5 = 25	10 x 9 = 90	186	Medium
Windstorm	2 x 8 = 16	7 x 8 = 56	5 x 4 = 20	10 x 9 = 90	182	Medium
Landslide	2 x 8 = 16	7 x 9 = 63	5 x 2 = 10	10 x 4 = 40	129	Low
Volcano	2 x 2 = 4	7 x 2 = 14	5 x 2 = 10	10 x 10 = 100	128	Low

Source: Salem NHMP Steering Committee, 2022-2023.

The following subsections 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 https://www.oregon.gov/lcd/NH/Documents/Approved_2020ORNHMP_09_RA3.pdf.

DOGAMI Multi-hazard Risk Assessment

The Department of Geology and Mineral Industries (DOGAMI) performed a risk assessment for the communities of Marion County, Oregon, with funding provided by the Federal Emergency Management Agency. The City of Salem is located in Marion and Polk Counties. The west portion of Salem that is within Polk County is included in this report, examined individually and designated as City of Salem (West Salem). The report, which is attached as Appendix G describes the methods and results of natural hazard risk assessments performed in 2021 and 2022 by DOGAMI within the study area shown below in Figure 57. The purpose of this project is to provide communities within the study area a detailed risk assessment of the natural hazards that affect them to enable them to compare hazards and act to reduce their risk. The risk assessment contained in this project quantifies the impacts of natural hazards to these communities and enhances the decision-making process in planning for disaster.

The DOGAMI Geohazards Analyst arrived at these findings and conclusions by completing three main tasks: compiling an asset database, identifying, and using best available hazard data, and performing natural hazard risk assessment.

In the first task, he created a comprehensive asset database for the entire study area by synthesizing assessor data, U.S. Census information, Hazus-MH[10] general building stock information, and building footprint data. This work resulted in a single dataset of building points and their associated building characteristics. With these data he was able to represent accurate spatial location and vulnerability on a building-by-building basis.

The second task was to identify and use the most current and appropriate hazard datasets for the study area. Most of the hazard datasets used in this report were created by DOGAMI; some were produced using high-resolution lidar topographic data[11]. While not all the data sources used in the report are countywide, each hazard dataset was the best available at the time of writing.

In the third task the DOGAMI Geohazards Analyst, Matt Williams, performed risk assessments using Esri® ArcGIS Desktop® software. He took two risk assessment approaches: (1) estimated loss (in dollars) to buildings from flood (recurrence intervals) and earthquake scenarios using FEMA Hazus®-MH methodology, and (2) calculated 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, wildfire, and volcanic lahar.

The findings and conclusions of this report show the potential impacts of hazards in communities within Marion County.

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[10] Hazus is a nationally standardized risk modeling methodology developed by FEMA. Hazus-MH (for Multi-Hazard) identifies areas with high risk for natural hazards and estimates physical, economic, and social impacts of earthquakes, hurricanes, floods, and tsunamis.

[11] Lidar (Light Detection and Ranging) is a remote sensing technology that uses light in the form of a pulsed laser to measure variable distances to the Earth. When combined with other data, it will generate precise, accurate, and high-resolution three-dimensional images of the surface of the earth, vegetation, and the built environment.

- While earthquake damage will occur throughout the entire county, extensive damage and losses are more probable in the northeastern portion of the county and areas of high liquefaction prone soils. Hazus-MH earthquake simulations illustrate the potential reduction in earthquake damage through seismic retrofits.
- Some communities in the study area have moderate risk from flooding, and DOGAMI quantified the number of elevated structures that are less vulnerable to flood hazard. The areas that are most vulnerable from flood hazard within the study are buildings along the Mill Creek (near Salem) between Turner and Salem and along Labish Ditch in Keizer.
- The analysis shows that new landslide mapping based on improved methods and lidar information show some communities are at risk to landslide hazard, including developed areas in the southwest part of Salem.
- Exposure to channel migration hazard is high for areas and communities along the Pudding River and Santiam and North Santiam Rivers.
- The wildfire hazard data used in this study was created prior to the unprecedented 2020 Labor Day Wildfires, however the results corresponded to the actual impacts of the 2020 Labor Day Wildfires in the county.
- Lahar hazard is a potential risk and could have significant impact for areas and the communities along the North Santiam River. The study's findings indicate that most of the critical facilities in the study area are at high risk from an earthquake and channel migration. DOGAMI found that the two biggest causes of population displacement are earthquake and landslide hazard.

Results were broken out for the following geographic areas (City of Salem in bold):

- Unincorporated Marion County (rural)
- Community of Hayesville
- Community of Brooks
- Community of Marion
- City of Aumsville
- City of Detroit*
- City of Gates*
- City of Hubbard
- City of Jefferson
- City of Mill City*
- City of St. Paul
- City of Salem (West Salem)*
- City of Scotts Mills
- City of Sublimity
- City of Woodburn
- Community of Four Corners
- Community of Butteville
- Community of Labish Village
- Community of Mehama
- City of Aurora
- City of Donald
- City of Gervais
- City of Idanha
- City of Keizer
- City of Mount Angel
- City of Salem
- City of Silverton
- City of Stayton
- City of Turner

*Portions of the cities of Detroit, Gates, and Mill City that were within Linn County are included in this report. The City of Salem that was within Polk County was examined individually and designated as City of Salem (West Salem).

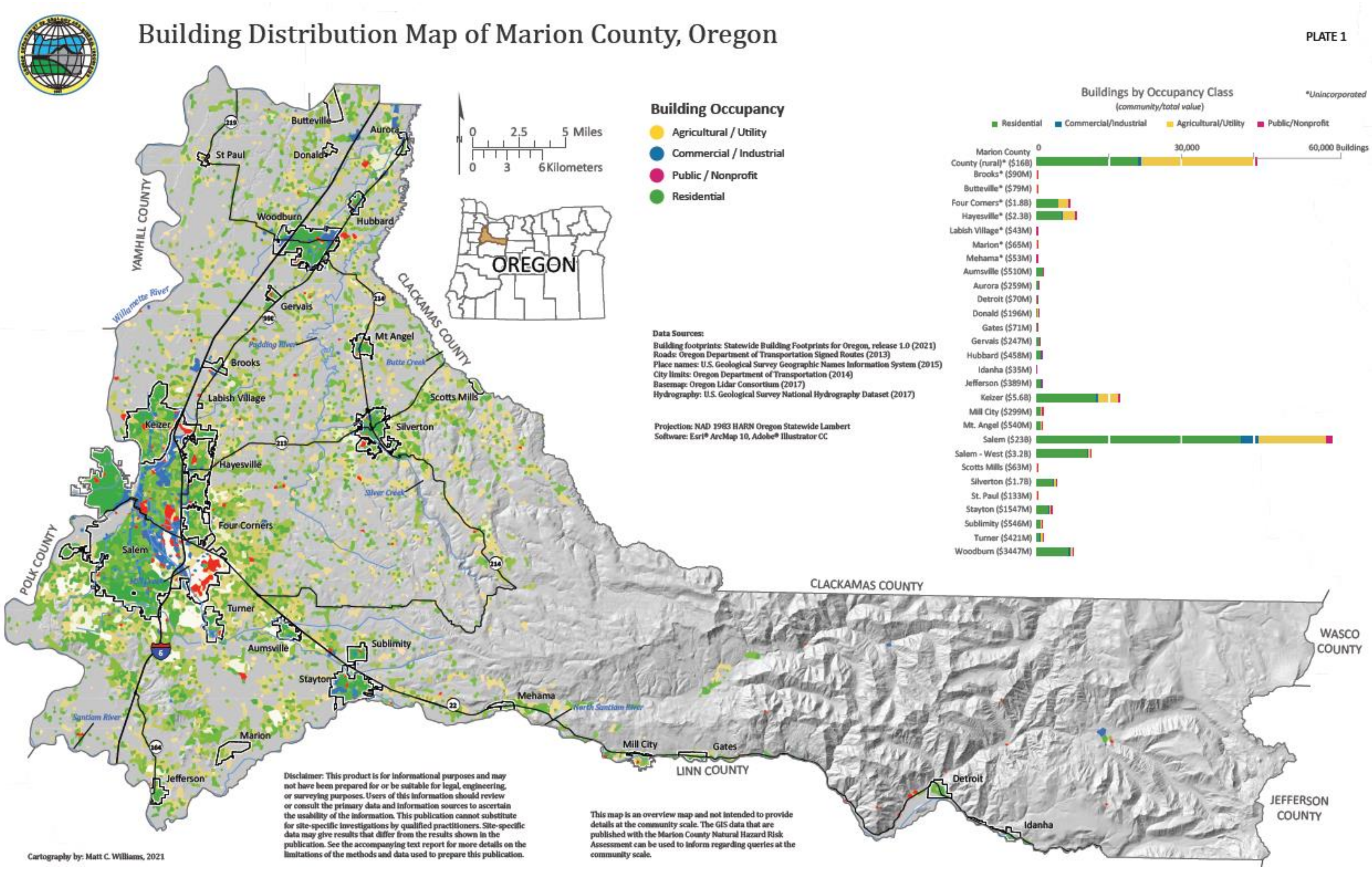
The following table provides selected county data regarding total number buildings in the county, the number of buildings affected by a hazard event, and estimated loss value of those affected buildings.

Table 22 Selected Countywide Results

Selected Countywide Results Total buildings: 170,562 Total estimated building value: $62 billion	
Mt. Angel Deterministic Magnitude 6.8 Earthquake Scenario Red-tagged buildings[a]: 7,479 Yellow-tagged buildings[b]: 17,028 Loss estimate: $6.7 billion	**100-year Flood** Number of buildings damaged: 2,552 Loss estimate: $126 million
Landslide (High and Very High-Susceptibility) Number of buildings exposed: 7,470 Exposed building value: $2.7 billion	**Channel Migration Zone (30-year):** Number of buildings exposed: 826 Exposed building value: $300 million
Wildfire (High and Moderate Risk): Number of buildings exposed: 2,819 Exposed building value: $814 million	**Lahar (1,000 to 15,000-year):** Number of buildings exposed: 1,789 Exposed building value: $415 million
[a]Red-tagged buildings are considered uninhabitable due to complete damage. [b]Yellow-tagged buildings are considered limited habitability due to extensive damage.	

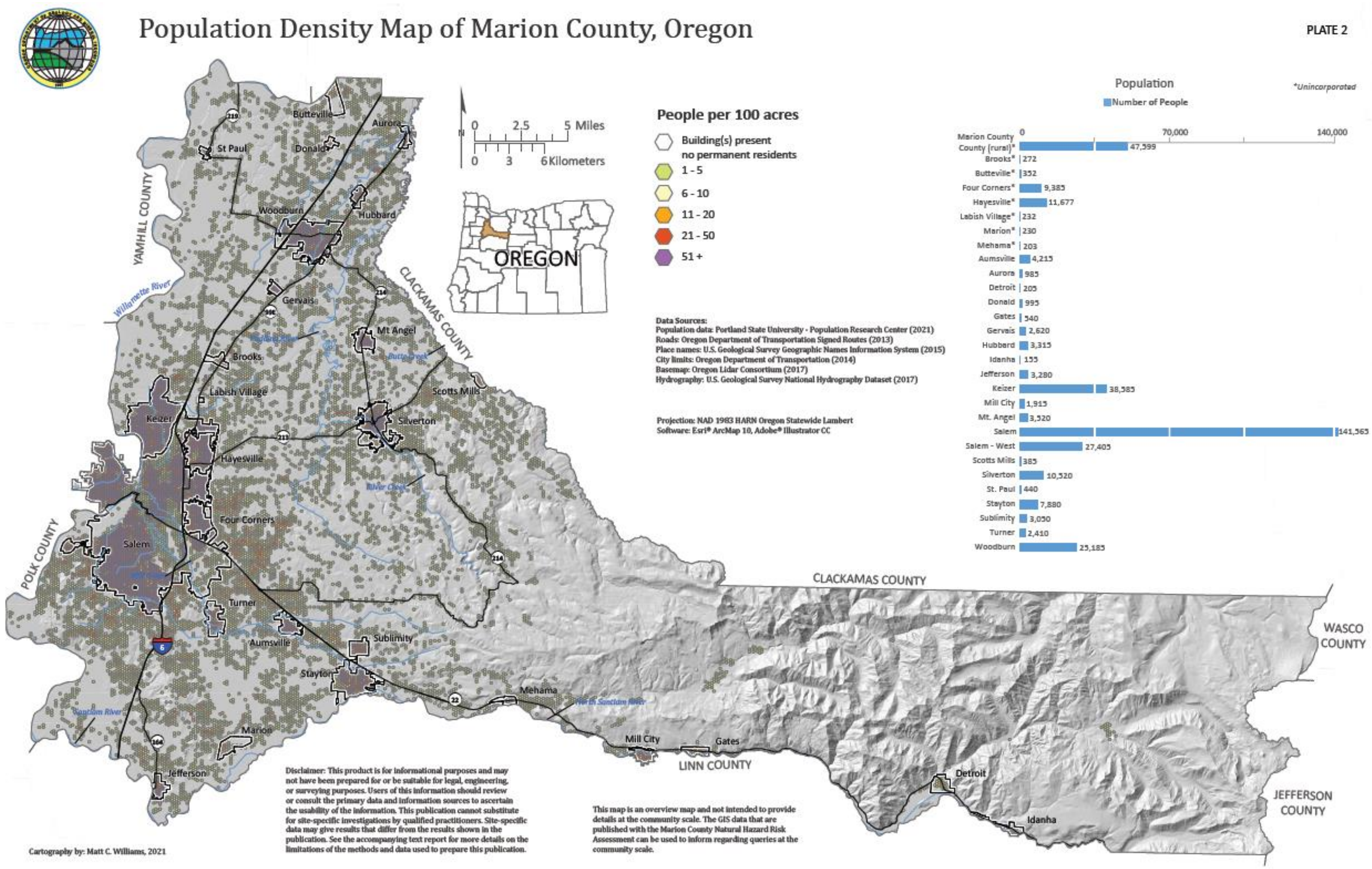
Source: Williams et al., 2022

Figure 55 Building Distribution Map of Marion County, Oregon



Source: Williams et al., 2022

Figure 56 Population Density Map of Marion County, Oregon



Source: Williams et al.,2022

Future Climate Projections

Oregon's Department of Land Conservation and Development contracted with the Oregon Climate Change Research Institute (OCCRI) to analyze the influence of climate change on natural hazards. The complete report is available as Appendix H. The scope of the analysis that yielded the report entitled *Future Climate Projections Marion County, Oregon* is limited to the geographic area encompassed by Marion County, however OCCRI has performed this analysis for many other Oregon counties to inform the Natural Hazard Mitigation Plan update process. A small portion of Salem is in Polk County; however, OCCRI has not executed a *Future Climate Projections* report for Polk County. Based on the commonality between the two counties when it comes to current and future climate projections, this NHMP relies on the Marion County report issued in June 2022.

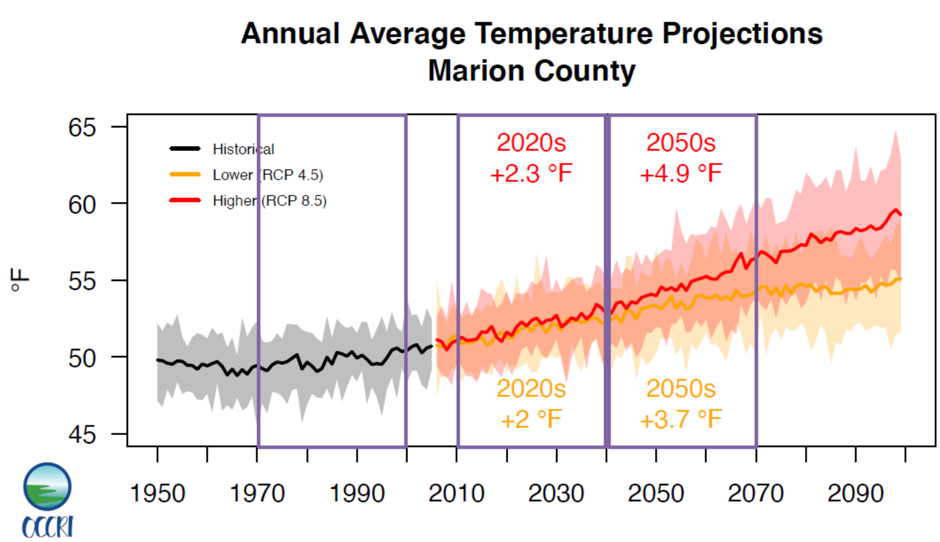
The *Future Climate Projections Marion County, Oregon* report states,

> 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). Climate change is expected to increase the likelihood of natural hazards such as heavy rains, river flooding, drought, heat waves, wildfires, and episodes of poor air quality, and to decrease the likelihood of cold waves.

During the twenty-first century, the average temperature in Marion County is projected to warm at a rate like that of Oregon as illustrated in Figure 58.

Figure 57 Annual Average Temperature Projections, Marion County

Historical Baseline	2020s	2050s
1971–2000	2010–2039	2040–2069



Source: Dalton et al., 2022

The OCCRI report states that climate change is expected to increase the occurrence of many climate-related natural hazards. Confidence levels and changes in natural hazard risks are illustrated in Figure 59. Confidence that the risk of heat waves will increase is very high given strong evidence in the peer-reviewed literature, consistency among the projections of different global climate models, and robust theoretical principles underlying increasing temperatures in response to ongoing emissions of greenhouse gases. Additionally, confidence that the risk of many other natural hazards (e.g., drought, reduced air quality, and flooding) will increase as climate changes is high or medium, reflecting moderate to strong evidence and consistency among models. However, these risks are influenced by multiple secondary factors, in addition to, increasing temperatures. Confidence in changes in risks is indicated as low for windstorms, for example, if projections suggest relatively few to no changes or evidence is limited.

OCCRI analysts projected the direction of change in the risks of climate-related natural hazards and the level of confidence in those changes. Very high confidence means that the direction of change is consistent among nearly all global climate models and there is strong 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 strong 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.

Figure 58 Confidence Level and Changes in Natural Hazard Risk

	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 Rains Flooding Wildfire	Heat Waves
Risk Unchanging =	Windstorms			
Risk Decreasing ↓				Cold Waves

Source: Dalton et al., 2022

Future climate projections for Marion County are presented in the OCCRI report are relevant to specified natural hazards for the 2020s (2010–2039) and 2050s (2040–2069) relative to the 1971–2000 historical baseline. The projections are presented for a lower greenhouse gas emissions scenario (RCP[12] 4.5) and a higher greenhouse gas emissions scenario (RCP 8.5) and are based on multiple global climate models. 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 are included in the main report.

Heat Waves

The number, duration, and intensity of extreme heat events is expected to increase as temperatures continue to warm.

In Marion 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 (RCP 4.5) and higher (RCP 8.5) emissions scenarios.

In Marion County, the number of days per year with temperatures 90°F or higher is projected to increase by an average of 16 days (range 5–27 days) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

In Marion County, 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, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

Cold Waves

Cold extremes will become less frequent and intense as the climate warms. In Marion County, the number of cold days (maximum temperature 32°F or lower) per year is projected to decrease by an average of 4 days (range -2– -5 days) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

In Marion County, 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, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

Heavy Rains

The intensity of extreme precipitation is expected to increase as the atmosphere warms and holds more water vapor.

In Marion County, the number of days per year with at least 0.75 inches of precipitation is not projected to change substantially. However, 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 0–35%) and 11% (range 0–24%), respectively, relative to the1971–2000 historical baselines, under the higher emissions scenario.

In Marion County, 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

[12] Representative Concentration Pathways (RCPs)

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 mid- to low elevations in Marion 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 summer soil moisture, low spring snowpack, low summer runoff, and low summer precipitation, is projected to become more frequent in Marion County by the 2050s.

Wildfire

Wildfire risk, expressed as the average number of days per year on which fire danger is very high, is projected to increase in Marion County by 13 days (range -6–32) by the 2050s, relative to the historical baseline, under the higher emissions scenario.

In Marion County, the average number of days per year on which vapor pressure deficit is extreme is projected to increase by 27 days (range 9–43) by the 2050s, compared to the historical baseline, under the higher emissions scenario.

Reduced Air Quality

The risk of wildfire smoke in Marion County is projected to increase. The number of days per year on which the concentration of wildfire-derived fine particulate matter results in poor air quality is projected to increase by 19%, and the concentration of fine particulate matter is projected to increase by 91%, from 2004–2009 to 2046–2051 under a medium emissions scenario.

Loss of Wetlands

In Marion 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.

Windstorms

Limited research suggests little if any change in the frequency and intensity of windstorms in the Northwest as a result of climate change.

Expansion of Non-native Invasive Species

In general, non-native invasive plant species in Marion County are likely to become more prevalent in response to projected increases in temperature, especially minimum winter temperature, and increases in the frequency, duration, and severity of drought. However, many of these responses are uncertain, are likely to vary locally, and may change over time.

Community Characteristics

Vulnerability assesses the extent to which people are susceptible to injury or other impacts resulting from a hazard as well as the exposure of the built environment or other community assets (social, environmental, economic, etc.) to hazards. The exposure of community assets to hazards is critical in the assessment of the degree of risk a community has to each hazard. Identifying the populations, facilities and infrastructure at risk from various hazards can assist the county in prioritizing resources for mitigation and can assist in directing damage assessment efforts after a hazard event has occurred. The exposure of county and city assets to each hazard and potential implications are explained in each hazard section in Volume I.

Community vulnerabilities are an important component of the NHMP risk assessment. Vulnerability includes the percentage of population and property likely to be affected under an “average” occurrence of the hazard. For more information regarding specific community vulnerabilities, reference each Hazard Identification section above and Community Profile (Volume II: Appendix C). Data sources for the following community vulnerability information can be found in the Community Profile, unless otherwise noted below. City of Salem and the DLCD natural hazards planners evaluated the best available vulnerability data to develop the vulnerability evaluation presented below.

Population

The socio-demographic qualities of the community population, in terms of language, race and ethnicity, age, income, educational attainment, and health are significant factors that can influence the community’s ability to cope, adapt to and recover from natural disasters. In addition, other indicators such as graduation rate, quality of schools, and median household income can have long term impacts on the City of Salem economy and stability of the community ultimately affecting future resilience. Historically, 80 percent of the disaster burden falls on the public, according to the U.S. Census Bureau. Of this number, a disproportionate burden is placed upon unrepresented and socially vulnerable populations, particularly children, elderly, disabled people, minorities, and low-income persons. Population vulnerabilities can be reduced or eliminated with proper outreach and community mitigation planning.

Population Vulnerabilities

The following information was obtained from the U.S. Census Bureau’s American Community Survey.

- Even though approximately 90% of the city population is reported as proficient in English, approximately 24.1% of the population speaks another language other than English at home. These populations would serve to benefit from mitigation outreach, with special attention to cultural, visual and technology sensitive materials.
- Salem is experiencing demographic changes in terms of age of the population. Persons 65 years of age and older made up 15.0% of the total City of Salem population in 2021, increasing 1.7% in two years. Persons 18 years and younger comprised 24.2% of the population, a level that was nearly stable from the previous

two years. Socially vulnerable populations, particularly the younger and older populations, require additional support from the community at large.

- As of 2020, approximately 15% of Salem's population is over the age of 64; that percent is less than the State (18.6%), Marion County (16.4%), and Polk County (18.7%).
- The Salem age dependency ratio, which is the ratio of population typically not in the work force (less than 15, greater than 64), is 64.5. This is about the same for Oregon (63.5) but lower than Marion County (67.7) and Polk County (69.1); the age dependency figure for the Marion County increased by 13 in the past five years
- Approximately 13.3% of Salem population over age 64 lives alone.
- Approximately 7.0% of the City of Salem population has a mobility (ambulatory) difficulty, and this expands to 24.5% of the population for people over 64. Moreover, the population with a cognitive difficulty averages 6.9%.
- Salem's real median income ($63,927) is lower than the State ($71,562), Marion County ($64,406), and Polk County ($71,532).
- Approximately 12.8% of the total Salem population lived at or below the poverty line in 2020, including 14.3% of children under 18.
- Approximately 88% of the population over 25 has graduated high school or higher and about 28.9% have a bachelor's degree or higher; 12% of the population does not have a High School degree.
- About 52.8% of Salem renters and 36% of owners with a mortgage spend more than 30% of their income on housing.

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, as a strong and diverse economic base increases the ability of individuals, families, and the community to absorb disaster impacts for a quick recovery.

Economic Vulnerabilities

- According to the Oregon Employment Department, Salem unemployment as of December 2022 has increased to 4.5% from 3.5% in December 2021 . In the event of a large—scale disaster, unemployment has the potential to rise when businesses and companies are unable to overcome the ramifications of the hazard event.
- The largest sectors of employment in the Salem Metropolitan Service Area are Trade, Transportation, and Utilities (16%), Private Educational and Health Services (16%), Local Government (10%), Manufacturing (9%), and State Government (7.5%), according to the Oregon Employment Department's Mid-Valley Industry Employment Forecast 2021-2031. In the event of a natural disaster, the government sector may not be as vulnerable in the short term as other sectors; however, other large industries such as agriculture, wholesale trade of electronic equipment and manufacturing of food products are industries that may be significantly affected by a disaster as these basic industries tend to rely on sales outside of the community.

- The Transportation, Warehousing, and Utilities sector is expected to have the most growth from 2021 to 2031 at 44%. Leisure and Hospitality (36%) is the next closest growth sector (Oregon Employment Department, 2023).
- Two-thirds of Salem's workforce lives outside of the city limits.

Natural Environment

The capacity of the natural environment is essential in sustaining all forms of life including human life, yet it often plays an underrepresented role in community resiliency to natural hazards. The natural environment includes land, air, water, and other natural resources that support and provide space to live, work and recreate (Mayunga, 2007). Natural capital 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 natural systems are impacted or depleted by human activities, those activities can adversely affect community resilience to natural hazard events.

Environmental Vulnerabilities

- Forest ecosystems are vulnerable to drought, wildfire, and severe storm impacts.
- The primary river that flows through Salem is the Willamette River; other important streams that pass through are Mill Creek, the Mill Race, Pringle Creek, and the Shelton Ditch. Smaller streams in the eastern part of the city include Clark Creek, Jory Creek, Battle Creek, Croisan Creek and Clagget Creek, while glen Creek and Brush Creek flow through West Salem. These streams frequently flood, and while this can provide natural benefits, flooding can inflict personal injury and property damage.
- According to the *Annual Water Quality Report* 2022, Salem obtains its drinking water from the North Santiam River watershed, located in the Cascade Foothills. As this is the primary source of drinking water for Salem, it is imperative to consider the hazards that can affect water quality, including flooding, landslides and drought.
- The combination of a growing population and development intensification can lead to the increasing risk of hazards, threatening loss of life, property and long-term economic disruption if land management is inadequate, such as floodplain development that is common throughout the City of Salem.

Built Environment, Critical Infrastructure Sectors, and Lifelines

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

- Mobile home and other non-permanent residential structures account for 4.2% of the housing in Salem. These structures are particularly vulnerable to certain natural hazards, such as earthquake, windstorms, and heavy flooding events, according to the U.S. Census.
- Based on U.S. Census data, approximately two-thirds of the residential housing in Salem was built before the current seismic building standards of 1990.
- Approximately 54% of residential structures were constructed prior to the local implementation of the flood elevation requirements of the 1970's (city Firms- were not completed until 1979).

Critical Infrastructure Sector Vulnerabilities

According to the U.S. Department of Homeland Security, there are various critical infrastructure sectors whose, "assets, systems, and networks, whether physical or virtual, are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof." There are 16 recognized sectors[13] some of which is addressed here for City of Salem. According to FEMA's Local Mitigation Handbook (2013), critical facility is "Structures and institutions necessary, in the community's opinion, for response to and recovery from emergencies. Critical facilities must continue to operate during and following a disaster to reduce the severity of impacts and accelerate recovery."

- Salem is the State Capital and the second largest city in Oregon, it is critical to maintain the quality of built capacity (transportation networks, critical facilities, utility transmission, etc.) throughout the area, as it is likely that surrounding jurisdictions will seek assistance from Salem.
- Roads and bridges in the City of Salem are highly vulnerable to hazards specifically earthquakes. Because bridges vary in size, materials, siting, and design, any given hazard will affect them differently. Salem must also consider roads and bridges obstructed beyond the city limits, as this will likely have significant impacts on access in and out of Salem.
- Virtually all state and city roads and bridges in Salem are vulnerable to multiple hazards including flood, landslide, 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.
- All of Salem's power is generated outside the region; there is no redundancy in power transmission and only limited redundancy in the power distribution network.

The list on the following pages identifies the critical facilities, essential facilities, public infrastructure, and social service facilities considered critical by the 2022/2023 Salem NHMP Steering Committee. Some critical facilities are also identified above in the Hazard

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[13] Critical infrastructure sectors include chemical; commercial facilities; communications sector; critical manufacturing; dams; defense industrial base; emergency services; energy; financial services; food and agriculture; government; healthcare and public health; information technology; nuclear reactors, materials, and waste; transportation systems; and water and wastewater systems.

Identification and Assessment section, either listed by name or simply noted the number of critical facilities that will be affected by a specific hazard event.

Table 23 Critical and Essential Facilities for the City of Salem

Facility Name	Property Use	Facility Priority
Communications		
AT&T Cell Tower Generator	Utility or Distribution system- other	1
AT&T Cell Tower Generator Building	Outbuilding or shed	1
Cctv Studio	Radio- television studio	1
KCCS Radio Tower	Mercantile- business- other	1
OSP Radio Shop	Mercantile- business- other	1
State of Oregon - Data Center (ETS)	Business office	1
Verizon Cell Tower	Property Use- other	1
AT&T Cell Tower @ Mission Mill	Utility or Distribution system- other	2
Centurylink	Communications center	2
Salem Clinic - Call Center	Communications center	2
United States Postal Services - Bldg. Shell	Post office or mailing firms	2
US Post office	Mercantile- business- other	2
US Post office	Post office or mailing firms	2
West Salem Post office	Post office or mailing firms	2
Vista Post office	Post office or mailing firms	4
Emergency Coordination / Communication		
Anderson Readiness Center	Undetermined	1
Willamette Valley Communication Center	Public or government- other	1
Emergency Response		
Bureau of Criminal Id.	Mercantile- business- other	1
City of Salem - Sand Storage	Undetermined	1
City of Salem Public Works Operations	Public or government- other	1
Falck office/Warehouse - Bldg. Shell	Undetermined	1
Fire Station 9	Fire station	1
Fire Station 7	Fire station	1
Fire Station1	Fire station	1
Fire Station 10	Fire station	1
Fire Station 2	Fire station	1
Fire Station 3	Fire station	1
Fire Station 8	Fire station	1
Marion County Maint. Shop	Mercantile- business- other	1
Marion County Public Works Fuel Tank	Service station- gas station	1
Marion County Sherriff's office	Business office	1
Modular Scenario Bldg..	Police station	1
Oregon Dept. Emergency Management & ODOT	Manufacturing- processing	1
Oregon Dept. Environmental Quality	Mercantile- business- other	1
Oregon National Guard Military HQ	Defense- military installation	1
Oregon National Guard Open Hanger- Hanger 2- Hanger 3- Flight Ops	Defense- military installation	1
Oregon State Forestry - Hanger	Storage- other	1
Oregon State Police	Mercantile- business- other	1
Oregon State Police Headquarters	Business office	1
OSP Fleet Services	Police station	1
OPS Installation Center	Mercantile- business- other	1

Facility Name	Property Use	Facility Priority
OSP Vehicle Storage	Parking garage- general vehicle	1
Salem Fire Station 11	Fire station	1
Salem Fire Ems office	Mercantile- business- other	1
Salem Fire Station 5	Fire station	1
Salem Police Department	Police station	1
Salem Fire Station 4	Fire station	1
Salem Fire Station 6	Fire station	1
Board of Parole & Post-Prison Supervision	Business office	2
Oregon Dept. of Corrections Fuel Island	Mercantile- business- other	2
OSP Storage	Storage- other	2
Police & Weighmaster 8	Mercantile- business- other	2
DPSST - Program Services/Multi-Purpose	Public or government- other	3
DPSST - Skills Bldg..	Public or government- other	3
DPSST - Tactical Training Facility	Street- other	3
Energy		
BPA Salem Substation	Electrical distribution	2
Comcast - Electrical Bldg.	Electrical distribution	2
NW Natural	Mercantile- business- other	2
PGE	Electrical distribution	2
PGE Energy Storage Facility	Energy production plant- other	2
Portland General Electric	Mercantile- business- other	2
Salem Electric	Mercantile- business- other	2
Governance		
City Hall / Civic Center	Undetermined	1
City of Salem	Business office	1
City of Salem	Fixed-use recreation places- other	1
City of Salem It Department	Undetermined	1
State Capitol Bldg..	Assembly- other	1
Department of Energy	Business office	2
Marion County Juvenile Pro.	Mercantile- business- other	2
Oregon Municipal Electric Utilities	Mercantile- business- other	2
Revenue Building	Mercantile- business- other	2
State of Oregon Central Computer Facility	Computer center	2
State of Oregon Dept. of Justice	Business office	2
State of Oregon Dept. of Justice	Business office	2
Transfer/Recycle Station	Mercantile- business- other	2
Department of Human Services	Business office	3
Department of Justice	Mercantile- business- other	3
Marion County Juvenile Administration office	Business office	3
Mid-Willamette Valley Council of Governments	Mercantile- business- other	3
National Weather Service	Electric-generating plant	3
Oregon Judicial Dept/ It Division	Mercantile- business- other	3
Oregon Judicial Department	Mercantile- business- other	3
Oregon Judicial Department West	Undetermined	3
Oregon Judicial Department East	Undetermined	3
Oregon State Judicial Department	Business office	3
State of Oregon	Mercantile- business- other	3
Oregon State Court Adm	Warehouse	3
Assoc. of Comm. Mental Health Program	Mercantile- business- other	4

Facility Name	Property Use	Facility Priority
Bureau of Labor and Industries	Mercantile- business- other	4
Bureau of Land Mgmt	Mercantile- business- other	4
Department of Human Resources	Mercantile- business- other	4
Department of Human Services	Mercantile- business- other	4
Department of Justice	Mercantile- business- other	4
Department of Motor Vehicles (DMV)	Business office	4
Department of Ag Modular	Business office	4
Department of Ag Plant Division	Mercantile- business- other	4
Department of Agriculture	Mercantile- business- other	4
Department of Motor Vehicles	Mercantile- business- other	4
DEQ	Business office	4
DHS Community Resources	Mercantile- business- other	4
DHS OHP SSP Division	Business office	4
DHS/APD/HCC	Business office	4
DHS/OHA	Business office	4
DHS-Salem	Mercantile- business- other	4
DHS-State of Oregon - Bldg. Shell	Business office	4
Interim Healthcare of Oregon	office: veterinary or research	4
Labor & Industries	Mercantile- business- other	4
Labor & Industries - Bldg. Shell	Undetermined	4
Liberty Square Parking	Parking garage- general vehicle	4
Marion County Assessor office	Business office	4
Marion County Association of Defenders	Business office	4
Marion County Environmental Health	Mercantile- business- other	4
Marion County Health Department	Mercantile- business- other	4
Marion County Managed Care	Post office or mailing firms	4
Marion Polk Bldg. Industry Association	Mercantile- business- other	4
Marion Polk Legal Aid	Mercantile- business- other	4
Marion Polk Med. Society	Mercantile- business- other	4
Occupational Health & Safety Division	Business office	4
OR State Hwy Weighmastrs	Mercantile- business- other	4
OR State Council for Seniors	Mercantile- business- other	4
Oregon Dept. Administrative Services	Mercantile- business- other	4
Oregon Dept. of Fish and Wildlife	Business office	4
Oregon Dept. of Human Services	Mercantile- business- other	4
Oregon Dept. of Human Services	Business office	4
Oregon Dept. of Human Services-Facilities	Storage- other	4
Oregon Employment Dept.	Business office	4
Oregon Judicial	Mercantile- business- other	4
Oregon School Board Association	Mercantile- business- other	4
Oregon State Archives	Ind.- utility- defense- agriculture- mining- other	4
Oregon State Forestry	Mercantile- business- other	4
Oregon State Forestry	Mercantile- business- other	4
Oregon State Forestry	Mercantile- business- other	4
Oregon State Grange	Mercantile- business- other	4
Oregon State Marine Board	Mercantile- business- other	4
Oregon State Supreme Court	Business office	4
Public Works Warehouse	Parking garage- general vehicle	4
Salem-Keizer Public Schools	Parking garage- general vehicle	4

Facility Name	Property Use	Facility Priority
Social Security office	Mercantile- business- other	4
State Board Arch. Exam	Mercantile- business- other	4
State Building Codes - A	Mercantile- business- other	4
State Building Codes - B	Mercantile- business- other	4
State Building Codes - C	Mercantile- business- other	4
State of OR Lands Div.	Mercantile- business- other	4
State of Oregon	Business office	4
State of Oregon - Bldg. Shell	Business office	4
State of Oregon - Bldg. Shell	Business office	4
State of Oregon - DHS/OHA	Storage- other	4
State of Oregon - Public Service Bldg..	Mercantile- business- other	4
State of Oregon - Stiff -Jarmen House	Business office	4
State of Oregon (Consumer & Business Ser	Warehouse	4
State of Oregon Employee Relation Board	Mercantile- business- other	4
State of Oregon Ford House - Bldg. Shell	Business office	4
State of Oregon Library - Bldg. Shell	Undetermined	4
State of Oregon/Employmt	Storage- other	4
Willamette University Carnegie	Mercantile- business- other	4
Willamette University Legal Arts	Mercantile- business- other	4
Mass Care and Shelter		
State of Oregon Dept. of Corrections	Jail- prison (not juvenile)	1
Abioua Middle School	High school/junior high school/middle school	4
Alice Yoshikai Elementrary School	Elementary school- including kindergarten	4
Avamere- Bldg. Shell	Elementary school- including kindergarten	4
Baker School	Elementary school- including kindergarten	4
Battle Creek Elementary	Elementary school- including kindergarten	4
Boone Rd Fuel Tank	Public or government- other	4
Brush College Elementary	Elementary school- including kindergarten	4
Bush Elem School	Elementary school- including kindergarten	4
Capitol Christian School	Elementary school- including kindergarten	4
Career Technical Educational Center-SKSD	High school/junior high school/middle school	4
Cep office Building - Bldg. Shell	Public or government- other	4
Chapman Hill Elementary	Elementary school- including kindergarten	4
Chemawa Indian School	High school/junior high school/middle school	4
Columbia Hall	Convention center- exhibition hall	4
Convention Center - Bldg. Shell	Convention center- exhibition hall	4
Corban University	Educational- other	4
Crossler Middle School	Educational- other	4
Department of Business & Cons. Services - Bldg.	Public or government- other	4
Dept.of Corrections	Undetermined	4
Dept.of Forestry - Fire Cache	Warehouse	4

Facility Name	Property Use	Facility Priority
Dept. of Motor Vehicles	Manufacturing- processing	4
DPSST - Academic-Classrooms & office	Public or government- other	4
Dyehouse	Public or government- other	4
Eagle Charter School	Elementary school- including kindergarten	4
Elementary School	Elementary school- including kindergarten	4
Englewood School	Elementary school- including kindergarten	4
Environmental Learning Center - North Sa	High school/junior high school/middle school	4
Faye Wright Elementary School	Elementary school- including kindergarten	4
Grant School	Elementary school- including kindergarten	4
Hammond Elementary School	Elementary school- including kindergarten	4
High School	High school/junior high school/middle school	4
Highland Elementary School	Elementary school- including kindergarten	4
Hillcrest School - School Building	Undetermined	4
Hoover School	Elementary school- including kindergarten	4
Houck Middle School	Educational- other	4
Howard St School	Educational- other	4
Howard Street Charter School	High school/junior high school/middle school	4
Immanuel Elementary School	Educational- other	4
Internal Revenue Service	Public or government- other	4
Jackman-Long Building	Convention center- exhibition hall	4
Jesse M. Harritt Elementary	Elementary school- including kindergarten	4
Joint Forces Headquarters	Defense- military installation	4
Judson Middle School	High school/junior high school/middle school	4
Lee Elementary School	Elementary school- including kindergarten	4
Leslie Middle School	Educational- other	4
Liberty School -Main Building	Elementary school- including kindergarten	4
Marion County Courthouse	Courthouse	4
Marion County Health Department	Undetermined	4
Marion County Historical	Public or government- other	4
Marion County Jail	Jail- prison (not juvenile)	4
Mckay High School	High school/junior high school/middle school	4
Mckinley School	Elementary school- including kindergarten	4
Meyers Elementary School	Elementary school- including kindergarten	4
Middle School	High school/junior high school/middle school	4

Facility Name	Property Use	Facility Priority
Miller Elementary School	Elementary school- including kindergarten	4
Montessori Children House	Schools- non-adult- other	4
Morningside School	Elementary school- including kindergarten	4
North Salem High	High school/junior high school/middle school	4
ODOT Traffic Signal	Warehouse	4
Office of the State Chief Information officer	Public or government- other	4
Old Pringle School House	Elementary school- including kindergarten	4
OR Dept. General Services Warehouse	Warehouse	4
OR Dept. of Human Services	Manufacturing- processing	4
OR Dept. of Corrections- Metal Fab	Manufacturing- processing	4
OR School for Blind-Irvine Hall	High school/junior high school/middle school	4
Oregon Center for Clinical Investigation	Laboratory or science laboratory	4
Oregon Dept. of Transportation	Manufacturing- processing	4
Oregon Judicial Department - Human Resources Services Division	Public or government- other	4
Oregon State Archives	Warehouse	4
Oregon State Lottery	Public or government- other	4
Parrish Middle School	High school/junior high school/middle school	4
Pringle School	Elementary school- including kindergarten	4
Public Work/Carpenter	Warehouse	4
Queen of Peace School	Elementary school- including kindergarten	4
Richmond School	Elementary school- including kindergarten	4
Riviera Christian School & Daycare	Elementary school- including kindergarten	4
Roberts High School (Alt Ed)	High school/junior high school/middle school	4
Roots Acadamy	High school/junior high school/middle school	4
S.E.C. Modular #2	Elementary school- including kindergarten	4
Salem Academy High School	High school/junior high school/middle school	4
Salem Academy-Elementry	Elementary school- including kindergarten	4
Salem Armory Auditorium	Convention center- exhibition hall	4
Salem Christian Academy	Elementary school- including kindergarten	4
Salem Clinic	Warehouse	4
Salem Heights School	Elementary school- including kindergarten	4
Salem Keizer School District	Educational	4
Salem Reserve Center Modular	Defense- military installation	4
Salem Senior Center (Center 50+)	Assembly- other	4
Santiam Correctional Facility	Jail- prison (not juvenile)	4

Facility Name	Property Use	Facility Priority
Schirle School	Elementary school- including kindergarten	4
South Salem High School	High school/junior high school/middle school	4
South Salem Senior Center	Public or government- other	4
Sprague High School	High school/junior high school/middle school	4
St Johns Lutheran School	Day care- in commercial property	4
St Joseph'S Elementary School	Educational- other	4
St Vincent Depaul School	Elementary school- including kindergarten	4
Stephens Middle School	High school/junior high school/middle school	4
Straub Middle School	High school/junior high school/middle school	4
Sumpter School	Elementary school- including kindergarten	4
Supreme Court Building	Public or government- other	4
Swegle Elementary School	Elementary school- including kindergarten	4
Tokyo International University	Educational- other	4
U.S. Dept. of Agriculture	Warehouse	4
Waldo Middle School	High school/junior high school/middle school	4
Walker Middle School	Elementary school- including kindergarten	4
Washington School	Elementary school- including kindergarten	4
West Salem Foursquare School	Elementary school- including kindergarten	4
West Salem High School	High school/junior high school/middle school	4
Wildfire Defense Systems	Warehouse	4
Willamette Academy- College Prep	High school/junior high school/middle school	4
Willamette Career Academy	High school/junior high school/middle school	4
Willamette University	Mercantile- business- other	4
Medical		
Kaiser Permanente	Clinics- doctors offices- hemodialysis cntr- other	1
Kaiser Permanente Dental	office: veterinary or research	1
Kaiser Permanente Medical	Clinics- doctors offices- hemodialysis cntr- other	1
Kaiser Skyline Clinic	Clinics- doctors offices- hemodialysis cntr- other	1
Marion County Dog Control	office: veterinary or research	1
Marion County Health & Human Services - Psychiatric Crisis Center	Hospital - medical or psychiatric	1
Northbank Surgical Center	Clinic- clinic-type infirmary	1
OR State Hospital Cottage R-02	Residential board and care	1
Oregon State Hospital	Hospital - medical or psychiatric	1
Oregon State Prison	Clinic- clinic-type infirmary	1

Facility Name	Property Use	Facility Priority
Permanente (Kaiser) Dental (Skylne)	Doctor- dentist or oral surgeon office	1
Psychiatric Facility	Hospital - medical or psychiatric	1
Rehabilitation Center	Hospital - medical or psychiatric	1
Salem Audiology Clinic	office: veterinary or research	1
Salem Clinic P.C.	Clinics- doctors offices- hemodialysis cntr- other	1
Salem Clinic P.C.	Health care- detention- & correction- other	1
Salem Clinic South - Bldg. Shell	Clinics- doctors offices- hemodialysis cntr- other	1
Salem Hospital	Hospital - medical or psychiatric	1
Salem Hospital	Mercantile- business- other	1
Salem Hospital/MRI Center	Clinics- doctors offices- hemodialysis cntr- other	1
Salem V.A. Clinic	Clinics- doctors offices- hemodialysis cntr- other	1
Urgent Care - Salem Hospital	Doctor- dentist or oral surgeon office	1
West Salem Clinic Mental clinic	Health care- detention- & correction- other	1
West Salem Family Medical Clinic	Doctor- dentist or oral surgeon office	1
Willamette Surgery Center	Hospital - medical or psychiatric	1
Willamette Urology Clinic - Bldg. Shell	Clinic- clinic-type infirmary	1
Work Release Center	Health care- detention- & correction- other	1
Marion County Health Department	Business office	2
Marion County Health Stor	Mercantile- business- other	2
Polk County Mental Health	Clinics- doctors offices- hemodialysis cntr- other	2
Salem Clinic Annex	Clinics- doctors offices- hemodialysis cntr- other	2
Salem Health Admin offices	Business office	2
ATI Physical Therapy	Clinics- doctors offices- hemodialysis cntr- other	4
Center for Medicare	Business office	4
Department of Veteran Affairs	Clinics- doctors offices- hemodialysis cntr- other	4
InterState Medical Group	Clinics- doctors offices- hemodialysis cntr- other	4
Marion County Gap House	Business office	4
Option Counseling and Family Services	Clinics- doctors offices- hemodialysis cntr- other	4
Portland DBT Institute	Clinics- doctors offices- hemodialysis cntr- other	4
Salem Health Outpatient Rehab Bldg. M	Clinics- doctors offices- hemodialysis cntr- other	4
Salem Hospital-Marketing	Mercantile- business- other	4
State Dental Lab	Mercantile- business- other	4
Willamette Valley Dental Assistant School	office: veterinary or research	4
Willamette Valley Eye Center	Clinics- doctors offices- hemodialysis cntr- other	4
Miscellaneous		
Marion County Housing Authority	Undetermined	3
Salem Housing Authority		3

Facility Name	Property Use	Facility Priority
School District 24J Reprographics	Warehouse	3
FACES of America DBA Family Literacy & Resource Center	Schools- non-adult- other	4
Howard Street Charter School Dance Studio	Educational	4
Little Bird Childcare	Preschool	4
Special Needs		
Department of Corrections-Dome Building	Business office	2
Oregon Dept. of Corrections	Storage- other	2
Dept. of Corrections	Mercantile- business- other	3
Assisted Living - Bldg. Shell	Undetermined	4
Battle Creek Memory Care	24-hour care Nursing homes- 4 or more persons	4
Bonaventure	Residential board and care	4
Boone Ridge Senior Living Community	24-hour care Nursing homes- 4 or more persons	4
Bridgeway Recovery	Health Care- Detention & Correction	4
Brookdale Senior Living	24-hour care Nursing homes- 4 or more persons	4
Brookstone Alzheimer Special Care Center	Health care- detention- & correction-other	4
Capitol Manor Health Care Complex	24-hour care Nursing homes- 4 or more persons	4
Care Takers House - Bldg. Shell	1 or 2 family dwelling	4
Carroll's Group Care Home	Residential board and care	4
CCPC Group Home (Licensed)	Residential board and care	4
Center for Autism & Related Disorders (CARD)	Mental retardation/development disability facility	4
Court St House	Health care- detention- & correction-other	4
Davita Salem Dialysis	Clinics- doctors offices- hemodialysis cntr- other	4
Day Care - Bldg. Shell	Day care- in commercial property	4
Developmental Disability Services - IDD Services	Mental retardation/development disability facility	4
Englewood East	Health care- detention- & correction-other	4
Family Hd Start Pr Schoo	Mental retardation/development disability facility	4
Faye Wright Square Building #1	24-hour care Nursing homes- 4 or more persons	4
Firehouse Diabetes & Endocrine Center	Doctor- dentist or oral surgeon office	4
Fmc- D.S. of West Salem	Hemodialysis unit	4
Gibson Creek Assisted Living Residence	Residential board and care	4
Great Circle Recovery	Alcohol or substance abuse recovery center	4
Harmony House	Health care- detention- & correction-other	4
Harmony House of Salem	Residential board and care	4
Harmony Manor	Health care- detention- & correction-other	4
Hawthorne House of Salem	24-hour care Nursing homes- 4 or more persons	4

Facility Name	Property Use	Facility Priority
Hidden Lakes Retirement Residences	Mental retardation/development disability facility	4
Immed Care & Med Clinic	Health care- detention- & correction- other	4
Iuditas' Memory Care	24-hour care Nursing homes- 4 or more persons	4
Juvenile Department	Hemodialysis unit	4
Juvenile Probation	Health care- detention- & correction- other	4
Kairos NW - Cadenza	24-hour care Nursing homes- 4 or more persons	4
Kroc Center RJ's Preschool	Preschool	4
Kuebler Early Learning Center	Preschool	4
Lds Church Classroom	Schools- non-adult- other	4
Little Bird Preschool	Preschool	4
Little Me Academy	Preschool	4
Little Red Schoolhouse	Day care- in commercial property	4
Madrona Hills Ret Ctr	Health care- detention- & correction- other	4
Mainstream Housing	Health care- detention- & correction- other	4
Marion & Polk Healthy Start	Health care- detention- & correction- other	4
Marion County Alcohol & Drug Treatment	Mercantile- business- other	4
Marion County Dog Control	Health care- detention- & correction- other	4
Marion County Health & Human Services - Adult Behavioral Health	Residential board and care	4
Marion County Health & Human Services - Adult Mental Health	Clinics- doctors offices- hemodialysis cntr- other	4
Marion County Health and Human Service - Horizon House	Residential board and care	4
Marion County Health & Human Services - Adult Behavioral Health	Residential board and care	4
Marion County Juv. Dept- Boys Gap Program	Health care- detention- & correction- other	4
Marion County Juvenile Detention	Reformatory- juvenile detention center	4
Marion County Juvenile- Girls Gap Program	Health care- detention- & correction- other	4
Meadow Creek Village	Health care- detention- & correction- other	4
Mid-Willamette Valley Hospice	Residential board and care	4
Monica Custer Care Home	Health care- detention- & correction- other	4
Neil Carroll Group Home	Residential board and care	4
Northwest Human Services	Clinics- doctors offices- hemodialysis cntr- other	4
Northwest Rehabilitation Associates- Inc	Clinics- doctors offices- hemodialysis cntr- other	4
NW Human Services - West Salem Clinic Mental Health	Clinics- doctors offices- hemodialysis cntr- other	4
Oregon Medical Centers- LLC dba First Choice Chiropractic and Rehabilitation	Clinics- doctors offices- hemodialysis cntr- other	4

Facility Name	Property Use	Facility Priority
Pacific Cardiovascular Surgical Center	Clinics- doctors offices- hemodialysis cntr- other	4
Pheasant Hill-Labor 27	Health care- detention- & correction- other	4
Prestige Senior Living at Orchard Height	Residential board and care	4
Psychiatric Crisis Center (Marion County Health & Human Services)	Residential board and care	4
Records Storage	Health care- detention- & correction- other	4
Redwood Crossing Residential Care & Shelter Facility	Residential board and care	4
Redwood Heights Assisted Living	Health care- detention- & correction- other	4
Regency Woodland	24-hour care Nursing homes- 4 or more persons	4
Seed of Faith Ministries	Residential board and care	4
Seniors Care Sweet Home	24-hour care Nursing homes- 4 or more persons	4
Serenity Lane Treatment Center	Alcohol or substance abuse recovery center	4
Sherman Manor	Health care- detention- & correction- other	4
Simonka House	Health care- detention- & correction- other	4
Skilled Nursing - Bldg. Shell	24-hour care Nursing homes- 4 or more persons	4
So. Salem Rehabilitation	24-hour care Nursing homes- 4 or more persons	4
Substation Sheriff office	Health care- detention- & correction- other	4
Sunny Manor Inc	Health care- detention- & correction- other	4
Sunnyglen Retirement	Health care- detention- & correction- other	4
Sweet Bye & Bye - Coral Springs	Residential board and care	4
Sweet Bye N Bye	24-hour care Nursing homes- 4 or more persons	4
Team Bailey Inc	Residential board and care	4
The Springs At Willowcreek	Health care- detention- & correction- other	4
The Sweet Bye N Bye - Reflections Memory Care	Residential board and care	4
Tierra Rose Care Center	24-hour care Nursing homes- 4 or more persons	4
Union Gospel Mission of Salem	Residential board and care	4
Valley Mental Health	Clinics- doctors offices- hemodialysis cntr- other	4
Via Verde - Cottage 15	Asylum- mental institution	4
Vickie Harbaugh House	Residential board and care	4
Vida Integrative Medicine & Mental Health	Clinics- doctors offices- hemodialysis cntr- other	4
West Salem Prof Center	Health care- detention- & correction- other	4
Whitewood Gardens of Salem	24-hour care Nursing homes- 4 or more persons	4

Facility Name	Property Use	Facility Priority
Willamette Valley Community Action Agenc	office: veterinary or research	4
Willamette Valley Hospice	Mercantile- business- other	4
WindSong at Eola Hills Memory Care	24-hour care Nursing homes- 4 or more persons	4
Windsor Health & Rehabilitation Center	Health care- detention- & correction- other	4
Women at The Well Grace House	Residential board and care	4
Work Unlimited	Mental retardation/development disability facility	4
Transportation		
ODOT	Warehouse	1
Oregon Department of Transportation	Public or government- other	1
Oregon Dept. of Transportation	Rapid transit station	1
Sequential Bio Fuels Tank Farm	Flammable liquid distribution- F.L. pipeline	1
Sequential-Pacific Biodiesel	Flammable liquid distribution- F.L. pipeline	1
Department of Transportation	Mercantile- business- other	2
ODOT	Mental retardation/development disability facility	2
ODOT	Mercantile- business- other	2
ODOT Environmental	Mercantile- business- other	2
ODOT Transportation Bldg.	Mercantile- business- other	2
Oregon State Motor Pool	Mercantile- business- other	2
Transit off/Drivers Disp.	Mercantile- business- other	2
Airport Passenger Terminal- Tower	Undetermined	3
Chemeketa Parking Structure	Parking garage- general vehicle	3
Courthouse Square	Parking garage- general vehicle	3
Greyhound	Passenger terminal- other	3
Hospital Parking Garage	Parking garage- general vehicle	3
Liberty Square Parking	Parking garage- general vehicle	3
Library Parking	Parking garage- general vehicle	3
Marion St Parking Struct	Parking garage- general vehicle	3
ODOT Building X	Undetermined	3
ODOT Modular office	Business office	3
Pringle Parking Structure	Parking garage- general vehicle	3
Salem Transit	Mercantile- business- other	3
Salem Aviation Fueling - Bulk Storage	Parking garage- general vehicle	3
State Highway Division	Undetermined	3
State of Oregon Motor Pool	Mercantile- business- other	3
Transit Mall	Bus station	3
ODOT Building K	Business office	4
ODOT Geometrtonics	Mercantile- business- other	4
ODOT-Research	Mercantile- business- other	4
Ore State Aeronautic Div	Mercantile- business- other	4
Valley Oil Company	Mercantile- business- other	4
Water		
City Aquifer/Storage	Water utility	1
City of Salem - PW Pump Station	Sanitation utility	1
City of Salem Water Reservoir Control - Bldg. Shell	Water utility	1

Facility Name	Property Use	Facility Priority
City of Salem Wet Weather Treatment - Bldg. Shell	Sanitation utility	1
City of Salem Pump Station	Water utility	1
City of Salem Pump Station Generator	Outbuilding or shed	1
City of Salem Reservoir Ops. Bldg..	Ind.- utility- defense- agriculture- mining- other	1
City of Salem River Rd Pump Station	Sanitation utility	1
City Water Pump Station	Water utility	1
D & O Garbage Wash Rack - Bldg. Shell	Sanitation utility	1
D.O.T. Materials Testing Lab	Ind.- utility- defense- agriculture- mining- other	1
Marion County Archives	Ind.- utility- defense- agriculture- mining- other	1
Marion County Hazardous Waste Facility	Sanitation utility	1
National Guard Armory Auditorium	Ind.- utility- defense- agriculture- mining- other	1
Orchard Heights Pump Station	Water utility	1
Oregon Dept. of Agriculture	Ind.- utility- defense- agriculture- mining- other	1
Public Works Water Meter Repair	Warehouse	1
Pump Station - City of Salem - Bldg. Shell	Undetermined	1
Salem ASR	Water utility	1
Septic Building	Sanitation utility	1
Woodmansee Pumphouse	Water utility	1

Source: Salem NHMP Steering Committee, 2022-2023

Lifeline Sector Vulnerabilities

Community Lifelines, as with critical infrastructure and facilities, are the most fundamental services in the community that, when stabilized, enable all other aspects of society to function. The integrated network of assets, services and capabilities that provide community lifeline services are used day to day to support recurring needs. Lifelines enable the continuous operation of critical government and business functions and are essential to human health and safety or economic security, as described in the National Response Framework, 4th Edition.

The following lifeline sector analysis summary evaluates key resources and facilities within specific sectors through sector stakeholder feedback. The 2022/2023 Salem NHMP Steering Committee evaluated and decided to retain the information below that was originally presented in the *2017 Salem NHMP*. Please see **Appendix F** for the full lifeline sector analysis.

Energy

The energy sector is critical to modern life. Electricity is vital for virtually all household, business and emergency operations; liquid fuel is used for transportation, facility construction and repair, and backup power; natural gas is used for electricity generation, heating, cooking, powering vehicles, and other uses. The resilience, redundancy, and interdependencies of the energy sector will largely determine the timeline for emergency response and long-term community recovery. Diverse and redundant energy supply and distribution can significantly increase regional resilience.

Energy Summary Table

<table>
<tr>
<td>Critical Interdependencies:

Systems of all types are dependent on other systems to function. To operate, the communication sector is particularly <u>DEPENDENT ON</u>:
• Transportation
• Communication

Other critical lifeline sectors that <u>DEPEND ON</u> the communication sector to operate include:
• Public Safety and Emergency Management
• Transportation
• Water
• Communication
• Economy</td>
<td>Critical Vulnerabilities:

Each sector is vulnerable to a variety of impacts. The energy sector is particularly vulnerable to the following:
• Consumption consists almost entirely of one of three forms: electricity, liquid fuels, natural gas.
• Dependence on BPA for electric power; Marion County produces very little power locally.
• Lead time for ordering critical system components (e.g., transformers)
• Concentration of liquid fuel storage facilities in Portland; limited local fuel storage and supply.
• Lack of capability to pump fuel locally without power.
• Reliance on supply and distribution facilities located outside Marion County.</td>
</tr>
<tr>
<td colspan="2">Major Findings:
• Generators are co-located by equipment and are used at critical infrastructure throughout the county; however, require various fuel types depending on the unit.
• Oregon's fuel storage facilities are in Portland and are susceptible to failure due to soil liquefaction. The storage capacity on a normal day is six days; therefore, it is anticipated that fuel will be an undersupplied commodity during a Cascadia event. It will take 3-6 weeks to reacquire fuel.
• Energy is critically interdependent with the transportation, communication, and water sectors. For example, not having access to roads nor having the ability to communicate with responders leaves the energy sector extremely vulnerable. In addition, there is a need for energy in powering water treatment plants. These vulnerabilities are particularly heightened in areas where accesses via bridges or singular roads are susceptible to failure.
• The EPA regulates energy in terms of emissions limiting the capacity to produce additional energy resources.
• Damage assessments will be critical to capture the impacts to this lifeline. Downed trees, accumulating ice, and high winds can impact the resiliency of energy as a lifeline.
• The energy sector also prepares and mitigates against human-made disasters, such as cyberattacks.
• The energy sector grants people with uninterrupted services due to medical status during non-catastrophic events.
• An estimated 1-3 months of electrical service interruption during a Cascadia event.</td>
</tr>
</table>

Communications

The communication sector facilitates the rapid exchange of information across a broad range of systems and technologies. These include broadcast television and radio, telephone, cellular phone, cable, internet, two-way radio, and Ham (or amateur) radio.

Communication is an essential aspect of virtually all public and private sector activities. The ability to communicate is especially critical during an emergency. Notably, FEMA's Emergency Support Function #2 – Communications (ESF #2) specifically supports the restoration of communications infrastructure. The scope of ESF #2 includes "restoration of public communications infrastructure" and assisting "State, tribal, and local governments with emergency communications and restoration of public safety communications systems and first responder networks."

The assessment focused on (1) the adaptive capacity of the communications sector, (2) hazard-specific vulnerabilities to communication infrastructure, and (3) mitigation opportunities that can support uninterrupted or rapid restoration of communication capability during or following emergency or disaster event.

Communication Sector Summary

Critical Interdependencies:	Critical Vulnerabilities:
Systems of all types are dependent on other systems to function. To operate, the communication sector is particularly <u>DEPENDENT ON</u>: • Electricity • Energy (fuel) • Transportation Other critical lifeline sectors that <u>DEPEND ON</u> the communication sector to operate include: • Water (SCADA) • Electricity • Public Safety and Emergency Management • Transportation • Economy	Each sector is vulnerable to a variety of impacts. The communications sector is particularly vulnerable to the following: • All systems rely on electricity for operation and maintain generators for backup power. Generators rely on fossil fuels to operate leading to questions about what systems and services would be prioritized for gasoline/diesel fuel use if there were a disruption to fuel supply. Also, some generates operate on propane or natural gas, neither of which are included in state or federal energy assurance plans. • All systems rely on infrastructure (towers, antennae) spread across large areas, often in remote locations. Road access to repair equipment is a primary concern. • 911 service and other emergency communication relies on line-of-site microwave transmission. Even small changes in antennae alignment can disrupt transmission and require recalibration to re-establish connections between towers. Fiber infrastructure is vulnerable to earthquake damage, where lines are connected to bridge spans.

Major Findings:

- Many providers share infrastructure and or have their infrastructure co-located.
- Stakeholders are well prepared to address winter storms and other disasters if there is access to their facilities. Transportation, water, and energy are equally dependent on communication infrastructure. In addition, trees, wind, and ice are hazards that can impact this lifeline.
- During a power outage, battery and generator backups provide limited power for a varying duration of time depending on the fuel source and capacity. Redundancy is a needed resource for critical infrastructure that requires access and the supply of multiple fuel types, primarily gasoline and diesel. Notably, propane is a fuel source for some generators; however, propane will not be provided through state resources. Some generates operate on propane or natural gas, neither of which are included in state or federal energy assurance plans.
- All providers anticipate a 75-100% shutdown after a Cascadia event. Due to the roads and bridges being impassable, network connections could be severed.
- Largest barriers to respond in a Cascadia event include staff ability to respond, access to facilities, shortage of supplies to repair infrastructure, time, funding, and political support.
- Stakeholders recognize that their staff and families need to be prepared. To address this need, they are supporting a proactive approach to disasters. The Communications sector is working to train employees to be prepared for disasters so they can address their own immediate needs before safely addressing the needs of the sector post-event.
- Some towers have fiber optic lines as a redundancy. However, these lines are vulnerable in a catastrophic earthquake, in particular where lines are connected to bridge spans.
- Water infrastructure systems rely on communication for operations and maintenance through a "Supervisory Control and Data Acquisition" (SCADA) system. The system provides remote monitoring and control of the water system components. Radio system capability is needed for these systems to operate effectively. Much of this infrastructure is isolated. For example, Salem's infrastructure is located on an island.
- Amateur Radio provides critical back up to public safety radio communications in a disaster but does not provide the necessary capacity to meet emergency management needs. Jurisdictions should consider investing in satellite voice and data capabilities.
- Local servers may be damages in an earthquake. Jurisdictions should consider "cloud based" data storage solutions to backup vital records.

Transportation

Transportation is critical lifeline infrastructure. The transportation network facilitates the movement of people, goods, resources, and commerce throughout Marion County and beyond. The transportation system consists of local, state, and federal road and highway networks; passenger and freight rail; passenger and freight air service; pipelines; transit; dedicated bicycle and pedestrian systems; and limited water-based modes. All lifeline sectors depend on the transportation system.

Access to means of transportation is fundamental to human existence. Transportation infrastructure facilitates everything from a local trip to the park, drugstore, or place of employment to international trade and commerce. Furthermore, the ability to move people, goods and services is vital before, during and after emergency events. It is no accident that FEMA's number one Emergency Support Function is transportation. Emergency Support Function #1 – Transportation Annex (ESF #1) covers the following:

- Aviation/airspace management and control
- Transportation safety
- Restoration/recovery of transportation infrastructure

- Movement restrictions
- Damage and impact assessment

The scope of ESF #1 includes supporting, ". . . prevention, preparedness, response, recovery and ***mitigation*** activities among transportation stakeholders . . . [emphasis added]" and coordinating, "the restoration of the transportation systems and infrastructure."

Transportation lifeline sector participants identified several interconnected resources and elements of their operations. These include included roads, bridges, buses, and physical buildings. While this assessment focusses on infrastructure, participants noted that transportation staff and professionals are a critical resource as well.

Transportation Summary Table

<table>
<tr>
<td>Critical Interdependencies:
Systems of all types are dependent on other systems in order to function. In order to operate, the transportation sector is particularly <u>DEPENDENT ON</u>:
• Energy and Fuel
• Communication
• Business and Industry
• Public Works
Other critical lifeline sectors that <u>DEPEND ON</u> the transportation sector to operate include:
• Water
• Electricity
• Liquid fuel
• Public Safety and Emergency Management
• Public Works
• Economy</td>
<td>Crucial Vulnerabilities:
Each sector has a number of vulnerabilities. The transportation sector is particularly vulnerable to the following:
• Federal, state and local bridge infrastructure is particularly vulnerable to earthquake (especially ODOT facilities over the Willamette).
• System relies heavily on fossil fuels for construction, operation, and maintenance.
• Hwy 22 is the primary east-west connection; there are few redundant east-west routes.
• Significant backlog of deferred transportation maintenance projects.</td>
</tr>
<tr>
<td colspan="2">Major Findings:
• ODOT considers I-5 and Highway 22 to be critical routes. Other critical concerns include bridges, roads, communication, and energy including power and fuel.
• Much of the existing transportation infrastructure, including those of major roadways such as I-5, Highway 22, and Mission Road, are not seismically retrofitted and will likely experience structural failures during a Cascadia event.
• Following a Cascadia event, transportation will be limited for 6-12 months; aftershocks may extend that timeframe.
• Transportation is interdependent with communication, water, and energy systems and requires coordination and collaboration during the response and recovery process.
• Although winter storms continue to impact transportation systems, stakeholders respond to these events efficiently and continue to improve plans with every winter weather event. Downed trees, debris, and accumulated ice impact the response of this lifeline.
• Salem-Keizer Transit operates city and regional buses, dial-a-ride, CherryLift for people with disabilities, and coordinates non-emergent medical transportation services. They provide about 4 million rides a year and are currently working to improve individual employee preparedness as well as existing emergency plans.
• Salem-Keizer Public Schools transports an estimated 22,000 students a day including about 2,000 medically fragile students. The top priority for this organization is student safety.</td>
</tr>
</table>

• The electricity grid in Oregon is not particularly dependent on the transportation sector to operate. However, the power generation and distribution network does rely on the transportation network for construction as well as ongoing maintenance and repairs. • Conversely, all of the liquid fuel in the state is transported by one of three primary transportation modes: truck, rail, and pipeline. Therefore, the distribution fuel in the state is completely dependent on the transportation sector. • Like the electric grid, the communications sector is not particularly dependent on the transportation sector to operate. However, the power generation and distribution network does rely on the transportation network for construction as well as ongoing maintenance and repairs. • Business and industry are very dependent on the transportation sector. From the movement of raw material, to getting employees to and from work, to getting finished products to market, virtually all business and industry activity in the region is facilitated by transportation. • Public works is dependent on transportation in two primary ways. First, the transportation sector facilitates the movement of equipment, materials, and workers. Second, significant portions or components of public works' infrastructure are collocated within transportation rights of way.

Water

For the purposes of this assessment, the water sector includes information pertaining to drinking water, stormwater, and wastewater. Stakeholder participants included a range of local and regional infrastructure and service providers. The information provided in this summary is based on research of the county's water resources and infrastructure.

Ready access to virtually unlimited amounts of clean drinking water is often taken for granted, particularly here in the Pacific Northwest. Water is vital for basic daily living, for business and industry especially including agriculture, for fire protection and medical service provision, and for wastewater management. In addition, stormwater facilities provide critical protection from a variety of localized flood risks. FEMA Emergency Support Function #3 – Public Works and Engineering Annex (ESF #3) covers public works, including water, wastewater and stormwater services. Ensuring that all water related public works infrastructure is operational is critical to the function of any community.

Water Summary Table

Critical Interdependencies:	Crucial Vulnerabilities:
Systems of all types are dependent on other systems to function. To operate, the water sector is particularly <u>DEPENDENT ON</u>: • Electricity • Communication • Transportation • Liquid Fuel Other critical lifeline sectors that <u>DEPEND ON</u> the water sector to operate include: • Fire and EMS • Business and industry • Electricity	Each sector has many vulnerabilities. The transportation sector is particularly vulnerable to the following: • The water sector in Marion County consists of numerous local and regional systems. • Several reservoirs, transmission lines and the Salem Treatment Facility are vulnerable to multiple hazards. • Aquifer storage capacity not sufficient to meet need as a backup source.

Major Findings:

- People living in unincorporated areas of Marion County rely on wells and septic tanks.
- Low water reserves and low river flow pose a serious threat to the water supply.
- Some infrastructure pertaining to water systems are old which increases the risk vulnerability to withstand a Cascadia event. Impacted infrastructure located near rivers could cause service disruptions and flooding during an event or incident. Power is vital to the water facilities.
- Generators are co-located at critical facilities and need to be maintained requiring various fuel types in order to support redundancy.
- Road access is vital to conduct damage assessments and or repair impacted facilities.

SECTION 3: MITIGATION STRATEGY

The Mitigation Strategy establishes a policy framework and implementation pathway for reducing risk from natural hazards over the long term. This section outline outlines Salem's strategy to reduce or avoid long-term vulnerabilities to the identified hazards. Specifically, this section presents a mission, goals, and mitigation actions to reduce risk of damage from these hazards. The NHMP Steering Committee reviewed and updated the mission, goals and action items documented in this plan. Additional planning process documentation is Planning Process (Volume II: Appendix B).

Mitigation Mission

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

The mission of the *2023 Salem NHMP* is:

Identify and minimize risks and impacts to our community from natural hazards.

The NHMP Steering Committee reviewed the previous plans mission statement and agreed to revise the mission to align with other community objectives. Moreover, the revision of the mission statement intends to include the whole community. The Steering Committee believes the concise nature of the mission statement allows for a comprehensive approach to mitigation planning.

Mitigation Goals

Mitigation plan goals are more specific statements of direction that Salem citizens, and public and private partners can take while working to reduce the city's risk from natural hazards. These statements of direction form a bridge between the broad mission statement and particular action items. The goals listed here serve as checkpoints as agencies and organizations begin implementing mitigation action items.

Public participation was a key aspect in developing the plan goals. Meetings with the project Steering Committee, stakeholder interviews and public workshops all served as methods to obtain input and priorities in developing goals for reducing risk and preventing loss for natural hazards in Salem.

The Salem NHMP Steering Committee reviewed the previous plan goals in comparison to the State Natural Hazard Mitigation Plan (2020) goals. Like the mission statement revision, the Steering Committee determined they would revise and expand their existing goals based on the consideration and sensitivity of the whole community and climate -altered future.

All the plan goals are important and are listed below in no order of priority. 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. The *2023 Salem NHMP* goals are as follows:

Goal 1: Develop and implement mitigation activities to protect human life in the context of a climate-altered future.

Goal 2: Strive to protect existing buildings and infrastructure from the impacts of natural hazards.

Goal 3: Develop and implement strategies and policies to promote more resilient future development, infrastructure, and systems.

Goal 4: Strengthen communication, plan, practice, and coordinate emergency services among local, county, and regional governments and the private sector.

Goal 5: Enhance community resilience, including economic continuity and recovery, to reduce the impacts of natural hazards and promote efficient and effective recovery.

Goal 6: Preserve and rehabilitate natural systems to serve natural hazard mitigation functions and protect natural resources.

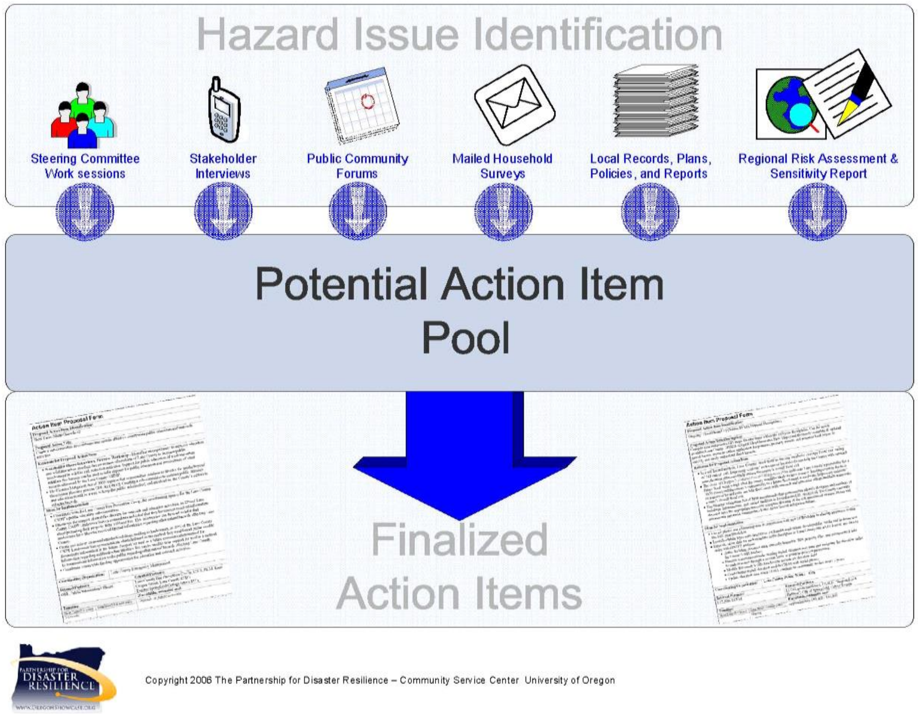
Goal 7: Develop programs to promote social resilience within the community recognizing that our most vulnerable communities are often those who have been historically underserved and marginalized, especially among those most vulnerable to natural hazards.

Mitigation Actions

Development Process

Mitigation actions are specific actions, projects, activities, or processes that Salem is considering implementing to reduce risk to people, property, and the environment from the impacts of natural hazard events. Therefore, mitigation actions identified through the planning process are an important part of the NHMP. The development of action items was a multi-step, iterative process that involved brainstorming, discussion, review, and revisions. Action items can be developed through several sources. Figure 59 illustrates some of these sources.

Figure 59 Develop of Action Items



Some of the action items were first created during the *2017 Salem NHMP* planning processes. Additional actions were created during the current NHMP review process. Much of this work occurred during the sixth, seventh, and eighth Steering Committee meetings held on February 21, 2023, April 19, 2023, and May 31, 2023. During these processes, the Steering Committees considered growth and changes in development patterns, considered local vulnerable populations, facilities, and infrastructure with respect to each identified hazard. Discussions involved potential actions to mitigate impacts to the vulnerable areas. The Oregon Department of Land Conservation and Development (DLCD) provided guidance in the development of action items by presenting and discussing actions that were used in other communities. DLCD also took note of ideas that came up in Steering Committee meetings and drafted specific actions that met the intent of the Steering Committee. All actions were then reviewed by the Steering Committee, discussed at length, and revised as necessary before becoming a part of this document.

One of the first steps was to discuss the status of the mitigation actions from the *2017 Salem NHMP*. The Steering Committee went through each mitigation action and ascertained if the action was completed or in progress.

- *Completed mitigation actions* are accomplishment and were removed from the table.
- *Mitigation actions* were removed from the table due to resource constraints or other factors.
- *Mitigation actions that were retained* were retained in full or modified to reflect the current situation more accurately.
- During this process, *new mitigation actions* were also identified.

Table 24 and Table 25 list each of the 2023 mitigation actions along with prioritization. Table 26 lists the status of each of the *2017 Salem NHMP* mitigation actions. A selection of the 2023 mitigation actions is detailed in mitigation action item worksheets located in Appendix A (Volume II). These worksheets identify the rationale for the project ideas for implementation, and potential coordinating and partner organizations. The action items worksheets are intended to assist plan holders to seek grant funding by summarizing mitigation actions in a manner that summarizes each project.

Action Item Worksheets

A selection of the mitigation actions identified in Table 24 and Table 25, have a corresponding action item form describing the activity, identifying the rationale for the project, identifying potential ideas for implementation, and assigning coordinating and partner organizations. The action item forms can assist the community in pre-packaging potential projects for grant funding. The form components are described below and are in Appendix A-1, *Priority Action Items* and Appendix A-2, *Action Item Pool* (Volume II: Appendix A).

Action Item

Each action item includes a brief description of the proposed action.

Alignment with Plan Goals

The plan goals addressed by each action item are identified as a means for monitoring and evaluating how well the mitigation plan is achieving its goals, following implementation.

Alignment with Existing Plans/Policies

This *2023 Salem NHMP* includes a range of action items that, when implemented, will reduce loss from hazard events in the city. Within the plan, FEMA requires the identification of existing programs that might be used to implement these action items. Salem currently addresses statewide planning goals and legislative requirements through their comprehensive land use plans, capital improvement plans, mandated standards, and building codes. To the extent possible, the jurisdictions will work to incorporate the mitigation action items into existing programs and procedures.

Many of the recommendations contained in the Salem NHMP are consistent with the goals and objectives of the existing plans and policies. Where possible, Salem will implement the recommendations and actions contained in the NHMP through existing plans and policies. Plans and policies already in existence have support from 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.

Rationale for Proposed Action Item

Action items should be fact-based and tied directly to issues or needs identified throughout the planning process. Action items can be developed at any time during the planning process and can come from several sources, including participants in the planning process, noted deficiencies in local capability, or issues identified through the risk assessment. The rationale for proposed action items is based on the information documented in the risk assessment (Section 2) and elsewhere in this plan.

Implementation through Existing Programs

For each mitigation action, the Mitigation Action Form provides ideas for implementation, which serve as the starting point for taking action. This information offers a transition from theory to practice. Ideas for implementation could include: (1) collaboration with relevant organizations, (2) alignment with the community priority areas, (3) applications to new grant programs, (4) tax incentives, (5) human resources, (6) education and outreach, (7) research, and (8) physical manipulation of buildings and infrastructure. This component of the mitigation action is dynamic, since some ideas may prove to not be feasible, and new ideas may be added during the plan maintenance process. When a mitigation action is implemented, more work may be needed to determine the exact course of action.

Plans and policies already in existence have support from residents, businesses, and policy makers. Many land use, comprehensive, and strategic plans are updated regularly, and can adapt easily to changing conditions and needs. Implementing the NHMP's mitigation actions through such plans and policies increases their likelihood of being supported and implemented. Salem will work to incorporate the mitigation actions into existing programs and procedures such as comprehensive land use plans, capital improvements plans, mandated standards, and building codes.

Ideas for Implementation

The ideas for implementation offer a transition from theory to practice and serve as a starting point for taking action. This component of the action item is dynamic, since some ideas may prove to not be feasible, and new ideas may be added during the plan maintenance process. Ideas for implementation include such things as: collaboration with relevant organizations, grant programs, tax incentives, human resources, education and outreach, research, and physical manipulation of buildings and infrastructure. When an action is implemented, more work will be needed to determine the exact course of action.

Coordinating Organization

The coordinating organization is a public agency with the regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring, and evaluation.

Partner Organizations

The internal and external organizations listed in the forms are potential partners recommended by the project Steering Committee but not necessarily contacted during the development of the plan. The coordinating organization should contact the identified partner organizations to see if they are capable of and interested in participation. This initial contact is also to gain a commitment of time and/or resources toward completion of the action items.

Internal partner organizations are departments within the city that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization.

External partner organizations can assist the coordinating organization in implementing the action items in various functions and may include local, regional, state, or federal agencies, as well as local and regional public and private sector organizations (special districts, etc.).

Potential Funding Sources

The Steering Committee has identified potential funding sources for each priority action item (listed on Action Item Form within Appendices A-1 and A-2). Example funding sources can include: the federal Pre-Disaster Mitigation and Flood Mitigation Assistance Programs; state funding sources such as the Oregon Seismic Rehabilitation Grant Program; or local funding sources such as capital improvement or general funds. An action item may also have multiple funding sources.

Estimated Cost

Where possible, an estimate of the cost for implementing the action item is included.

Timeline

Action items include short, mid-, and long-term activities. Each action item includes an estimate of the timeline for implementation. ***Short-term action items*** **(ST)** are activities that may be implemented with existing resources and authorities within two years. ***Mid-Term action items*** **(MT)** may require new or additional resources and/or authorities and may take from three to five years to implement. ***Long-term action items*** **(LT)** will require new or additional resources and/ or authorities and will occur after the next update cycles (five or more years to implement). ***Ongoing*** action items signify that work has begun and will either exist over an indefinite timeline, or an extended timeline, where possible specific measurable objectives are included.

Action Item Status

As action items are implemented or new ones are created during the plan maintenance process, it is important to indicate the status of the action item—whether it is **new** (created during this plan update cycle), **ongoing** (created in a previous planning process with some work accomplished), **deferred** (these actions have yet to see any significant work begin), or **complete** (these actions are considered accomplished and are listed in Appendix A). Documenting the status of the action will make reviewing and updating the mitigation Plan easier during the plan's five-year update and can be used as a benchmark for progress.

Mitigation Action Tables

The Mitigation Actions Tables portray the overall action plan framework and identify links between the plan goals, partnerships (coordination and partner organizations), and actions. The tables document a description of the action, the level of priority, the coordinating organization, partner organizations, timeline, and the plan goals addressed. Refer to Mitigation Action Worksheets (Volume II: Appendix A) for detailed information about each mitigation action.

For the *2023 Salem NHMP*, mitigation action priority was evaluated based on the mitigation goals and risk assessment results and with consideration and sensitivity of the whole community and climate-altered future

2023 Priority Actions

Action items identified through the planning process are an important part of the mitigation plan. Action items are detailed recommendations for activities that local departments, citizens, and others could engage in to reduce risk. Due to resource constraints, Salem is listing a set of high priority actions (Table 24) to focus attention on an achievable set of high leverage activities over the next five-years. Detailed implementation information for each priority action is listed in Appendix A-1. This plan identifies priority actions based on an evaluation of high impact hazards, resource availability and FEMA identified best practices.

2023 Action Item Pool

The action item pool (Table 25) presents a list of lower priority mitigation actions. Most of these actions carry forward from prior versions of this plan. This expanded list of actions is available for local consideration as resources, capacity, technical expertise, and/or political will become available. Appendix A-1, *Priority Action Items*, and Appendix A-2, *Action Item Pool*, provide detailed information about each of the priority action items (and some of the other actions). A blank action item form is included for use by the NHMP committee as additional action items are considered for implementation (Appendix A-3).

2017 Action Status

Table 26 is a summary of changes that includes the status and explanation of the *2017 Salem NHMP* mitigation actions as provided by the NHMP Steering Committee during the 2022-2023 NHMP planning process. The decisions to retain, modify, or remove the mitigation actions were also discussed at Steering Committee meetings. Follow up discussions occurred by email. This table has been refined to include an overall summary of the discussions. There is a column entitled “Priority” which identifies the priority of the mitigation actions in the *2017 Salem NHMP*. In that NHMP, several of them were listed with a priority rating.

Table 24 2023 Salem High Priority Action Items

Mitigation Action ID	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	NHMP Goals
Priority Actions					
Multi-Hazard					
MH #1	Identify, map, and periodically revisit network of critical routes. Identify street segments prone to flooding. Consider bridge age and condition within critical routes.	Salem Public Works, Salem Emergency Management	Salem Emergency Management, Cherriots, Neighborhood Associations, civic leadership groups	0-2 years	2, 3, 5
MH #6	Identify and plan to strengthen or replace unsafe public structures, infrastructure, and utilities (especially facilities critical to disaster and post-disaster planning/response).	Salem Public Works	Salem Fire , Police , Community Development, Urban Development,and Administrative Services; FEMA, ODOT	Ongoing	1, 2, 3, 5
MH #7	Maintain, improve, and test Salem's alert and warning systems to notify residents of incidents involving natural hazards and hazardous materials. Continue to educate the community about the systems value.	Salem Emergency Management	City Departments, ODOT, FEMA, OSHA	Ongoing	3, 4, 5, 7
MH #10	Conduct assessments of the short- and long-term needs for infrastructure to improve access to critical facilities and support systems for functional needs populations in the event of a hazard.	Salem Emergency Management	Salem Housing Authority, Salem Community Development, Marion County Emergency Management, Neighborhood Associations, Faith-Based Organizations, Oregon DHS, Non-Profits	Ongoing	1, 3, 4, 5, 7
MH #11	Plan for a network of neighborhood resilience hubs, indoor gathering places that can function as community centers, cooling centers, food distribution, places to access electricity during power outages, evacuation sites, day cares, and community learning centers	Salem Public Works, Salem Emergency Management, Salem Community Services	OPRD/State Fair, Marion County, Polk County, Oregon Joint Operation Center and National Guard, Salem-Keizer School District, Neighborhood Associations, Faith-Based Organizations, Non-Profits	3-5 years	1, 4, 5, 7
MH #12	Engage faith communities, social service agencies, nonprofits and neighborhood associations in building community resilience.	Salem Emergency Management	Salem Public Works and Community Development, Neighborhood Associations, Faith-Based Organizations, Non-Profits	0-2 years	4, 5, 7
MH #13	Analyze how historical inequities may make certain populations more vulnerable to inadequate transportation options in the event of an emergency. Incorporate best practices into emergency plans to ensure all users have adequate transportation options in emergency contexts.	Salem Public Works	Mid-Willamette Valley Council of Governments, ODOT, Marion County, Polk County	0-2 years	4, 5, 7

Source: Salem NHMP Steering Committee, updated 2023
Action ID Key: MH=Multi-hazard, AI=Air Quality, DR=Drought, EQ = Earthquake, EH=Extreme Heat, FL = Flood, LS=Landslide, HM=Hazardous Materials Incident, VE=Volcano Event, WQ=Water Quality/Emergency, WD=Windstorm, WT=Winter Storm, WF=Wildfire

Table 25 2023 Salem Action Item Pool

Mitigation Action ID	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	NHMP Goals
Action Item Pool					
Multi-Hazard					
MH #2	Coordinate with the Capitol Planning Commission to integrate natural hazard mitigation into State and City respective capital improvements.	Salem Community Development, Public Works	FEMA, OEM, Capitol Planning Commission	Ongoing	3, 4
MH #3	Maintain an inventory of the number and type of critical facilities including government buildings, facilities, and utilities within the community that are at reasonable risk for each hazard type.	Salem Public Works	Salem GIS, FEMA	Ongoing	2, 3, 5
MH #4	Maintain public outreach materials for all natural hazard risks addressed in the Salem Natural Hazards Mitigation Plan. Materials should include mitigation actions residents and businesses can implement to reduce their risk to natural hazards, and where they can obtain more detailed natural hazard information.	Salem Emergency Management, Salem Community Development, Salem Public Works	Salem Community Development and Public Works, FEMA, OSP, OEM, DOGAMI, DLCD	Ongoing	1, 3, 4, 5, 7
MH #5	Ensure Unified Development Code (UDC) updates consider specific hazards and help to mitigate risk for future development in identified/mapped high hazard areas.	Salem Public Works, Salem Community Development	DLCD, FEMA	Ongoing	1, 2, 3, 5, 6, 7
MH #8	Continue to follow and enforce regulations pertaining to hazard resistant construction-methods (wind, winter storm, landslide, etc.) where possible to reduce damage to utilities and critical facilities.	Salem Public Works	Salem Community Development, Emergency Management, and GIS, and Public Utility Commission, utility and communitication companies	Ongoing	1, 2, 3, 4, 5
MH #9	Ensure City planning documents and regulations align with regard to natural hazards mitigation and the actions in the Natural Hazards Mitigation Plan, particularly State Planning Goal 7.	Salem Community Development, Salem Public Works	Salem Emergency Management, Public Works, and City Administration, FEMA, American Planning Association, OEM, DLCD	Ongoing	3, 4
MH #14	Coordinate with the Council of Water Leaders to maintain strong partnerships in the watershed and allow rapid response to emerging issues and challenges.	Salem Public Works	Salem Emergency Management and Community Development, Salem Water Control District, municipal water providers, Tribes, city and county governments, nonprofits, businesses, interest groups, irrigators, state and federal agencies, elected officials	Ongoing	3, 4

Table 25 2023 Salem Action Pool (continued)

Mitigation Action ID	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	NHMP Goals
Action Item Pool					
Multi-Hazard					
MH #15	Conduct strategic public outreach and update information on website to provide residents with information about proper tree care and planning criteria in order to reduce tree-related hazards and encourage planting of climate appropriate trees to maintain a healthy and diverse tree canopy in Salem.	Salem Public Works	Salem Fire Department, ODOT, Portland General Electric, Salem Electric	Ongoing	1, 3, 4, 5, 7
Air Quality					
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.					
Drought					
DR #1	Update and continue to implement the North Santiam Watershed Drought Contingency Plan.	Salem Public Works	Marion County, Santiam Water Control District, City of Stayton, Linn Soil & Water Conservation District, Marion Soil & Water Conservation District, Norpac Foods, Inc., North Santiam Watershed Council, ODA, DEQ, ODF	0-2 years	1, 3, 4, 6
DR #2	Continue to promote water conservation to protect potable water supply and reduce impacts during drought through existing conservation programs and plans, such as the Clean Streams program, Drought Contingency Plan, Water Management and Conservation Plan, as well as any new initiatives.	Salem Public Works	North Santiam Watershed Council, Glenn Gibson Watershed Council, Marion and Polk Soil and Water Conservation Districts	Ongoing	1, 3, 4, 5, 7
DR #3	Expand the water conservation content on the website with an emphasis on providing more educational links and more information on water-efficient irrigation practices. Update water conservation brochures.	Salem Public Works	Salem Community Development	0-2 years	4, 5
See multi-hazard actions for additional applicable mitigation strategies.					
Earthquake					
EQ #1	Identify, inventory, and mitigate (as prioritization and resources allow) critical facilities and utilities that require seismic retrofit (consider structural and non-structural retrofit options).	Salem Emergency Management	Salem Public Works and Community Development, Salem-Keizer School District, FEMA, OEM, DOGAMI	Ongoing	2, 3, 5
EQ #2	Stay informed of the school districts plans about the indentification and prioritization of school district facility retrofits and upgrades.	Salem Emergency Management	Salem Community Development, Salem-Keizer School District, private schools, Chemeketa Community College, Willamette University, Corban University, EMA, OEM, DOGAMI	Ongoing	2, 4
See multi-hazard actions for additional applicable mitigation strategies.					

Table 25 2023 Salem Action Pool (continued)

Mitigation Action ID	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	NHMP Goals
Action					
Extreme Heat					
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.					
Flood					
FL #1	Update, maintain, and implement flood actions via a floodplain management plan in accordance with FEMA's Community Rating System guidelines.	Salem Public Works	Salem Emergency Management, Salem Fire Departments, Salem Operations and Engineering, FEMA, DLCD	Ongoing	3, 4, 5
FL #2	Improve and maintain the City of Salem's National Flood Insurance Program (NFIP) Community Rating System (CRS) rating in order to reduce flood risk and NFIP premiums.	Salem Public Works	Salem Community Development, Marion and Polk Counties, FEMA, DLCD, OEM	Ongoing	2, 3, 4, 5, 6, 7
See multi-hazard actions for additional applicable mitigation strategies.					
Landslide					
LS #1	Maintain landslide overlay maps using Light Detection and Ranging (LIDAR) data.	Salem Public Works	Salem GIS, FEMA, NOAA, DLCD, DOGAMI, City of Keizer and City of Turner, Marion County, Polk County	Ongoing	4
LS #2	Utilize the updated regional landslide risk maps (DOGAMI O-16-02) to identify hazard areas and collaborate with the Oregon Department of Geology and Mineral Industries to work on landslide risk reduction efforts; determine areas buildings, infrastructure, and utilities at risk to landslides and incorporate and utilize updated data when reviewing development applications.	Salem Community Development, Public Works	Salem GIS and Mapping, Emergency Management, DOGAMI, DLCD	Ongoing	2, 3, 4
See multi-hazard actions for additional applicable mitigation strategies.					

Table 25 2023 Salem Action Pool (continued)

Mitigation Action ID	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	NHMP Goals
Action Item Pool					
Volcano					
VO #1	Evaluate the impact of ash fall-out on HVAC systems in critical facilities. City could benefit from a quick sheet on this topic; guidance to contractors for maintenance.	Emergency Management	All city departments, DEQ, DOGAMI	3-5 years	2, 3, 4
See multi-hazard actions for additional applicable mitigation strategies.					
Water Quality/Emergency					
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.					
Windstorm					
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.					
Winter Storm					
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.					
Wildfire					
WF #1	Conduct wildfire prevention outreach, as outlined in the Marion County and Polk County (West Salem) Community Wildfire Protection Plans (CWPPs), to residents near the wildland-urban interface.	Salem Fire Department	Salem Public Works, Community Development, and Police Departments, ODF, Marion County Rural Fire District, Salem Suburban Fire District, Neighborhood Associations.	Ongoing	1, 2, 4, 5, 7
See multi-hazard actions for additional applicable mitigation strategies.					

Source: Salem Steering Committee, updated 2023

Action ID Key: MH=Multi-hazard, DR=Drought, EQ = Earthquake, EH=Extreme Heat, FL = Flood, LS=Landslide, HM=Hazardous Materials Incident, VE=Volcano Event, WD=Windstorm, WT=Winter Storm, WF=Wildfire

Table 26 2017 Salem NHMP Action Status

Mitigation Action ID	Priority	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	Status/Changes
Multi-Hazard						
MH #1	High	Identify and Designate Priority Transportation Routes.	Salem Public Works	Emergency Management, ODOT	Mid Term (3-5 Years)	Completed in 2020/Removed
MH #2	Action Pool	Coordinate with the Capitol Planning Commission to integrate natural hazard mitigation into State and City respective capital improvements.	Salem Community Development	Natural Hazards Mitigation Committee, FEMA, OEM, Campital Projects Advisory Board	Ongoing	Ongoing/Retained
MH #3	Action Pool	Develop an inventory of the number and type of critical facilities within the community that are at reasonable risk for each hazard type.	Salem Emergency Management	Natural Hazards Mitigation Committee, GIS, IT, FEMA	Short Term (0-2 years)	Ongoing/Modified
MH #4	Action Pool	Develop public outreach materials for all natural hazard risks addressed in the Salem Natural Hazards Mitigation Plan. Materials should include mitigation actions residents and businesses can implement to reduce their risk to natural hazards, and where they can obtain more detailed natural hazard information.	Salem Emergency Management, Salem Community Development, Salem Public Works	Salem Public Works, Community Development, FEMA, Oregon State Police, OEM, DLCD, DOGAMI	Ongoing	Completed/Modified as ongoing
MH #5	Action Pool	Include a post-disaster recovery and mitigation annex/appendix in the Salem Emergency Operations Plan that encourages property owners to incorporate retrofitting and mitigation measures in recovery efforts.	Salem Emergency Management	Natural Hazards Mitigation Committee, FEMA, Oregon State Police, OEM	Short Term (0-2 years)	Not Completed/Removed
MH #6	Action Pool	Ensure Unified Development Code (UDC) updates consider specific hazards when updating the Salem code for mitigating the location of future development in identified/mapped high hazard areas.	Salem Community Development	Salem Public Works, Natural Hazards Mitigation Committee, DLCD, FEMA	Ongoing	Ongoing/Retained
MH #7	Action Pool	Strengthen or replace unsafe public structures (especially facilities critical to disaster and post-disaster planning/response).	Salem Public Works	Salem Fire , Police , Community Development, Urban Development,and Administrative Services, FEMA, ODOT	Long Term (5+ years)	Progressing/Modified as ongoing
MH #8	Action Pool	Continue developing alert and warning systems to notify residents of incidents involving natural hazards and hazardous materials.	Salem Emergency Management	Salem Public Works, Police, GIS and Mapping, ODOT, FEMA, OSHA	Ongoing	Completed/Modified as ongoing

Table 26 2017 Salem NHMP Action Status (continued)

Mitigation Action ID	Priority	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	Status/Changes
Multi-Hazard						
MH #9	Action Pool	Enhance hazard resistant construction methods (wind, winter storm, landslide, etc.) where possible to reduce damage to utilities and critical facilities. In part, this may be accomplished by encouraging electric utility providers to convert existing overhead lines to underground lines.	Salem Public Works	Salem Community Development , Emergency Management, GIS and Mapping, Public Utilities Commission, Pacific Power	Ongoing	Ongoing/Retained
MH #10	Action Pool	Integrate the Mitigation Plan findings into planning and regulatory documents and programs including the Comprehensive Plan (particularly Goal 7).	Salem Community Development	Salem Public Works, Emergency Management, City Administration	Ongoing	Ongoing/Retained
MH #11	Action Pool	Participate in assessments of the short and long term needs for sheltering access and functional needs populations for all hazards.	Salem Emergency Management	Marion County, Salem Community Development, Oregon Department of Human Services	Short Term (0-2 years)	Progressing/Modified as ongoing
Drought						
DR #1	Action Pool	Complete and implement the North Santiam Drought Contingency Plan	Salem Public Works	City Departments, Marion County Emergency Management, Santiam Water Control District, City of Stayton, Linn Soil & Water Conservation District, Norpac Foods, Inc., ODA, DEQ, ODF, North Santiam Watershed Council	Short Term (0-2 years)	Completed in 2017/Modified with plan update
Earthquake						
EQ #1	High	Develop an inventory of un-reinforced masonry structures and develop appropriate mitigation action items to reduce the impacts of seismic events.	Salem Community Development Department	Urban Development, Public Works, Fire, FEMA, DOGAMI	Mid Term (3-5 Years)	Not Completed/Removed
EQ #2	High	Identify, inventory, and mitigate (as prioritization and resources allow) critical facilities and utilities that require seismic retrofit (consider structural and non-structural retrofit options).	Salem Emergency Management	Natural Hazards Mitigation Committee, Community Development Department, Public Works, FEMA, OEM, DOGAMI, School Districts	Ongoing	Ongoing/Retained
EQ #3	High	Create a bridge prioritization inventory based on major lifeline routes including state highways, routes, and major road arteries.	Salem Public Works/GIS	Salem Emergency Management, ODOT	Mid Term (3-5 Years)	Completed/Modified as multi-hazard action
EQ #4	High	Collaborate with SEDCOR to develop relevant public-private partnerships with businesses that can contribute to mitigation, response, and recovery.	Salem Public Works	Urban Development, Marion County Emergency Management, SEDCOR, Regional Solutions, UO EDAUC	Mid Term (3-5 Years)	Not Completed/Removed

Table 26 2017 Salem NHMP Action Status (continued)

Mitigation Action ID	Priority	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	Status/Changes
Earthquake						
EQ #5	High	Partner with the school districts to help identify and prioritize seismic retrofits to school district facilities.	Salem Emergency Management	Natural Hazards Mitigation Committee, Salem Community Development, FEMA, OEM, DOGAMI, Salem-Keizer School District, private schools, Chemeketa C.C., Willamette Uniersity, Corban University	Short Term (0-2 years)	Progressing/Modified as ongoing
Extreme Heat						
EH #1	No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.					
Flood						
FL #1	Action Pool	Update, maintain, and implement flood actions via a floodplain management plan in accordance with FEMA's Community Rating System guidelines.	Salem Public Works	Salem Emergency Management, Fire, Operations and Engineering, FEMA, DLCD, NFIP, Floodplain Management Committee	Ongoing	Completed in 2018/Modified as ongoing
FL #2	Action Pool	Improve the City of Salem's National Flood Insurance Program (NFIP) Community Rating System (CRS) rating in order to reduce flood risk and NFIP premiums.	Salem Public Works	Salem Community Development, DLCD, NFIP, FEMA, Marion and Polk Counties	Ongoing	Completed/Modified as ongoing
Landslide						
LS #1	Action Pool	Map areas of landslide risk adjacent to the North Santiam River (upstream of the Geren Island water intake structures) and areas impacted by a catastrophic failure of the Detroit or Big Cliff Dams.	Salem Public Works	Salem Communitiy Development, DOGAMI, US Army Corp, DLCD, FEMA, BLM, USFS	Long Term (5+ years)	Partially Completed/Removed
LS #2	Action Pool	Update landslide overlay maps using Light Detection and Ranging (LIDAR) data.	Salem Public Works	Natural Hazards Mitigation Committee, GIS and Mapping, FEMA, NOAA, DLCD, DOGAMI, Cities of Keizer and Turner, Marion and Polk Counties	Long Term (5+ years)	Completed/ Modified as ongoing
LS #3	Action Pool	Utilize the updated regional landslide risk maps (DOGAMI O-16-02) to identify hazard areas and collaborate with the Oregon Department of Geology and Mineral Industries to work on landslide risk reduction efforts; determine areas and buildings at risk to landslides; and propose Comprehensive Plan and land use policies accordingly.	Salem Community Development	Salem GIS and Mapping, Emergency Management, DOGAMI, DLCD	Short Term (0-2 years)	Progressing/Modified as ongoing

Table 26 2017 Salem NHMP Action Status (continued)

Mitigation Action ID	Priority	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	Status/Changes
Volcano						
VE #1	No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies					
Windstorm						
WD #1	Action Pool	Partner with public and private utilities to educate the public about hazardous trees and the damage they can cause in the event of a windstorm.	Salem Public Works	Salem Community Services, Parks Operations, Fire Department, ODOT, Portland General Electric, Electric Utilities	Ongoing	Ongoing/Modified as a multi-hazard action
Winter Storm						
WT #1	Action Pool	Partner with public and private utilities to educate the public about hazardous trees and the damage they can cause in the event of a winter storm.	Salem Public Works	Salem Community Services, Parks Operations, Fire Department, ODOT, Portland General Electric, Electric Utilities	Ongoing	Ongoing/Modified as a multi-hazard action
Wildfire						
WF #1	Action Pool	Conduct wildfire prevention outreach, as outlined in the Marion County and Polk County (West Salem) Community Wildfire Protection Plans (CWPPs), to residents near the wildland-urban interface.	Salem Fire Department	Salem Public Works, Community Development, Police, Community Services, ODF, Marion County Fire District #1, Salem Suburban Fire District, Neighborhood Associations	Ongoing	Completed/Retained as ongoing
Hazardous Materials Incident						
HM #1	Action Pool	Map facilities that handle or contain hazardous materials, rank them based on their level of risk, and refine response strategies for each situation in the event of an accident.	Salem Fire Department	Salem Emergency Management, Public Works, OSHA, Chamber of Commerce, Neighborhood Associations, ODOT, OEM, Oregon State Police, Oregon State Fire Marshall	Short Term (0-2 years)/Ongoing	Not Completed/Removed

Source: Salem Steering Committee, updated 2023

Action ID Key: MH=Multi-hazard, DR=Drought, EQ = Earthquake, EH=Extreme Heat, FL = Flood, LS=Landslide, HM=Hazardous Materials Incident, VE=Volcano Event, WD=Windstorm, WT=Winter Storm, WF=Wildfire

Integration

To achieve risk reduction, it is necessary to consider natural hazards mitigation in common planning processes, from land use regulation to infrastructure planning to emergency response.

Governmental and Institutional Capacity

In addition to the Emergency Management department, most departments within County and City governance structures have some degree of responsibility in building overall community resilience. Each plays a role in ensuring that jurisdiction functions and normal operations resume after an incident, and the needs of the population are met. Salem has the capacity for mitigation action through the following departments.

Fire Department: The City of Salem Fire Department operates within their protection area and is an all-hazard response agency that has been trained to mitigate emergencies involving fire, hazardous materials, and technical rescue (including rope rescue, water, confined space building collapse, and trench rescue). Emergency medical services and medical response are also a fundamental responsibility of the Salem Fire Department, and providers respond to a wide variety of medical calls, ranging from minor medical assistance to life-threatening events.

Police Department: The Salem Police Department provides law enforcement and public safety services to the City of Salem. As an agency, the Police Department's vision is to be the recognized leader of police practices through innovation, equipment, technology, and training to fight crime, enhance trust, and protect our community.

Community Development Department: The Community Development Department works to ensure the strength of the Salem community at the neighborhood level and citywide through support for planning and civic involvement, permitting, inspecting and, where needed, protecting historic community resources and providing library services. The Community Development Department includes the Building and Safety Division and Planning Division. The Building and Safety Division is responsible for the consistent application of building codes in construction and remodeling. The Planning Division aims to enhance the quality of life for residents and to promote a livable, vibrant city by facilitating and implementing the community's vision for Salem. City Planners can also provide information about protection of vegetation and trees along waterways and tree removal, including within the mapped floodplain.

Public Works Department: Salem's Public Works Department plans, constructs, and maintains the City's infrastructure including water supply systems, stormwater drainage system, wastewater treatment system, transportation systems, and park systems. In addition, the Public Works Development Services Division administers floodplain regulations.

Urban Development Department: The Urban Development staff administers programs and services that promote awareness of economic and community development programs, services, and economic incentives offered by the City of Salem and Urban Renewal Agency

(URA); leverages (URA)/City funds against available area sources for economic development activities; and works with economic development partners and the development community to actively promote investment in the Salem community.

Salem-Keizer Public Schools, Oregon School District 24J: Founded in 1855, the district is in the cities of Salem and Keizer. Educating more than 40,000 students in 65 schools, the district is the second-largest school district in Oregon. They hold institutional capacity for resilience to natural hazards through their facilities management personnel under the guidance of their elected School Boards.

Salem Municipal Airport (McNary Field): Owned and operated by the City of Salem, the airport is located approximately two miles from downtown Salem and is conveniently located at the juncture of Interstate 5 and State Highway 22. The 751-acre airport is home to more than 130 aircraft hangars and businesses, as well as the Oregon National Guard's Army Aviation Support Facility. There are currently no commercial flights operating from Salem.

Salem Area Mass Transit District/Cherriots: Cherriots is a public agency providing bus service over a 76 square mile area in Salem, Keizer, and the mid-Willamette Valley. The transit district was formed in 1979. The transit district also includes Cherriots Local, Cherriots Regional (formerly Chemeketa Area Regional Transportation System or CARTS), Cherriots LIFT (paratransit), and Cherriots Shop and Ride. Cherriots buses also include bike racks with a capacity for two bicycles. Other city social and transportation services are listed below in the section on Community Organizations and Programs.

Existing Plans and Policies

The City of Salem has existing authorities, policies, programs and resources in place. Integrating the existing capacity of local governments into the planning process improves the ability of local governments to implement the NHMP and to reduce risk of damage from natural hazards.

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. Plans and policies already in existence have support from residents, businesses, and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, and can adapt to changing conditions and needs.

The *2023 Salem NHMP* includes a range of recommended Mitigation Actions that, when implemented, may reduce Salem's vulnerability to natural hazards. These recommendations are intended to be consistent with the goals and objectives of the city's existing plans, policies and programs. Linking existing plans and policies to the NHMP helps identify what resources already exist that can be used to implement the Mitigation Actions identified in the *2023 Salem NHMP*. Implementing Mitigation Actions through existing plans, policies and programs increases their likelihood of being supported and maximizing the city's resources. Incorporating the NHMP into the Comprehensive Plan strengthens the provisions within the plan. Revising zoning regulations to identify hazardous areas through overlay zones where proscribed standards for safe development are required is another method of utilizing existing methods of regulating development to implement the Mitigation Actions of the NHMP.

Table 27, identifies the existing types of plans and implementing codes into which natural hazard mitigation goals, objectives, and actions may be integrated.

Table 27 City of Salem NHMP Supported Plans and Policies

Document	Year
Natural Hazards Mitigation Plan	2023, 2017 previous
Salem Emergency Management Plan	2023, 2018/2020 Previous
Salem Fire Department Standards of Cover, 2018-2023	2018
Salem Area Comprehensive Plan	2022
Salem Revised Code	2017 recodified
Title V, Community Development Standards	
Title VI, Wastewater, Water and Stormwater	
Title VII, Permits, Streets and Public Ways	
Title X, Unified Development Code	
Salem Climate Action Plan	2021
2021 Inventory of Community Greenhouse Gas Emissions	2023, 2019 previous
Salem's Community Energy Strategy	2010
Salem Floodplain Management Plan	2018
Salem Transportation System Plan	2020
Salem Comprehensive Park System Plan	2013
Salem Historic Preservation Plan 2020-2030	2020
Salem Water Management and Conservation Plan	2019
Salem Water System Master Plan	1994
Stormwater Master Plan	2020
Stormwater Drainage Basin Plans	2019
Battle Creek Basin Plan	
Mill Creek Basin Plan	
Pringle Creek Basin Plan	
Sheltering Crisis Response	2022
Snow and Ice Control Plan	2019
Community Forestry Strategic Plan	2013
Salem Strategic Plan 2021-2026	2021, 2017 previous
Salem Municipal Airport Master Plan	2012
Franzen Dam Emergency Operations Plan	2019
Croft Reservoir Dam Emergency Operation Plan	2018
North Santiam Watershed Council North Santiam Watershed Drought Contingency Plan	2018, update in process
Marion County Community Wildfire Protection Plan	2017

Source: *2023 Salem NHMP* Steering Committee

Community Organizations and Programs

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. The counties and cities can use existing social systems as resources for implementing such communication-related activities because these service providers already work directly with the public on several issues, one of which could be natural hazard preparedness and mitigation. The Community Profile (Volume II: Appendix C) provides a comprehensive list of community organizations and programs and offers a more thorough explanation of how existing community organizations and programs can be utilized for hazard mitigation.

Mitigation Activities and Resources

Mitigation through either regulatory or non-regulatory, voluntary strategies allow communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of a natural disaster, according to the *Planning for Natural Hazards: Oregon Technical Resource Guide*. The following are existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies and organizations. These activities and resources are categorized by hazard, as identified in the *2023 Salem NHMP*. In addition to what is identified here, the Grants appendix (Volume II: Appendix E), provides a comprehensive list of other mitigation resources.

Federal Resources

Multi-Hazard

Federal Emergency Management Agency

FEMA recommends preparing the home and the person for natural hazard events. (https://www.ready.gov/).

FEMA also recommends having a safe room in homes or small businesses to prevent residents and workers from "dangerous forces" of extreme winds to avoid injury or death. (https://www.fema.gov/fema-p-320-taking-shelter-storm-building-safe-room-your-home-or-small-business

National Oceanic and Atmospheric Administration

According to the NOAA National Severe Storms Laboratory, severe weather and storms use a variety of tools to forecast weather and storms. The National Severe Storms Laboratory is a major contributor to the scientific and engineering development of dual-polarized weather radar, which is now installed on the NWS weather radars. Dual-polarization radar can clearly identify rain, hail, snow, or ice pellets inside the clouds. In addition to observing a wide network of satellites, Doppler radars and automated surface observing systems, forecasters use their experience, together with computer forecast models to write and issue forecasts on what will happen next regarding weather and storms.

National Weather Service

The Portland Office of the National Weather Service issues severe winter storm watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. Four NWS offices cover Oregon: Portland (NW), Medford (SW), Pendleton (NE), and Boise (East and SE). The watches and warnings are broadcast over NOAA weather radio and are forwarded to the local news media for retransmission using the Emergency Alert System.

The Oregon landslide warning system as developed in direct coordination with the Portland NWS office and state agencies (Burns et al., 2021), such as DOGAMI.

Hazard Mitigation Grant Program

Following a major disaster declaration, the FEMA Hazard Mitigation Grant Program provides funding for long-term hazard mitigation projects and activities to reduce the possibility of damages from all future fire hazards and to reduce the costs to the nation for responding to and recovering from the disaster.

Air Quality

Environmental Protection Agency

The Clean Air Act of 1970 and the U.S. Environmental Protection Agency 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 "nonattainment" and are required to develop plans to come into compliance with the standards. Once compliant, a maintenance plan is developed to ensure that air quality will not be compromised in the future. According to DEQ's *Maintenance Areas in Oregon* data, Salem, together with neighboring city of Keizer are together an Air Quality Maintenance Area (AQMA) referred to as the Salem-Keizer area, which involves the following plans: *Portland-Vancouver Air Quality Maintenance Area (Oregon Portion)* and *Salem-Keizer Area Ozone Maintenance Plan* and *Salem-Keizer Area Carbon Monoxide Limited Maintenance Plan*.

According to EPA's *Process of Reviewing the National Ambient Air Quality Standards* website, 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 level of the standards is based and determine if changes to the level of the standards are warranted.

Drought

NOAA National Integrated Drought Information System

The National Integrated Drought Information System (NIDIS) program was authorized by Congress in 2006 (Public Law 109-430) and reauthorized in 2014 and 2019 with an interagency mandate to coordinate and integrate drought research, building upon existing federal, tribal, state, and local partnerships in support of creating a national drought early warning information system to make climate and drought science accessible and useful for decision makers and stakeholders.

Earthquake

USGS National Earthquake Information Center

The USGS National Earthquake Information Center (NEIC) operates a 24-hour-a-day service to determine the location and magnitude of significant earthquakes in the United States and around the world as rapidly and accurately as possible. This information is communicated to federal and state government agencies who are responsible for emergency response, to government public information channels, to national and international news media, to scientific groups (including groups planning aftershock studies), and to private citizens who request information. The NEIC issues rapid reports for those earthquakes with magnitudes at least 3.0 in the eastern United States and 3.0 in the western United States.

In addition, the USGS ShakeAlert Earthquake Early Warning System detects earthquakes quickly so alerts can be delivered to people before they feel shaking. ShakeAlert is a warning system for the west coast of the United States and can be directly integrated into healthcare facility communication and control systems, such as intercoms, to warn people and protect patients and staff. ShakeAlert does not predict earthquakes, rather it detects an earthquake moments after it begins, so that alerts can be sent to people in the affected area. Because information travels faster than earthquake waves, alerts can reach people quickly, even before they begin to feel shaking. ShakeAlert can be enabled on most cell phones.

FEMA and National Earthquake Hazards Reduction Program

FEMA administers several grant programs intended to reduce the risks to people and property posed by earthquakes. Although FEMA’s programs are not dedicated exclusively to earthquakes, they can be valuable sources of funding for risk reduction efforts targeting earthquakes or earthquakes and other hazards at state or local levels.

The National Earthquake Hazards Reduction Program (NEHRP) leads the federal government’s efforts to reduce the fatalities, injuries and property losses caused by earthquakes. The NEHRP is a coordination of complementary activities between these four federal agencies Federal Emergency Management Agency (FEMA), National Institute of Standards and Technology (NIST), National Science Foundation (NSF), and U.S. Geological Survey (USGS).

NEHRP also partners with state and local governments, universities, research centers, professional societies and trade associations and businesses.

FEMA’s National Earthquake Hazards Reduction Program (NEHRP) Earthquake State Assistance Grant Program was created to increase and enhance the effective implementation of earthquake risk reduction at the local level. NEHRP has two separate funding opportunities: Individual State Earthquake Assistance and Multi-State and National Earthquake Assistance funding opportunities, both of which are designed to increase and enhance the effective implementation of earthquake risk reduction at the national, state and local level.

Extreme Heat

National Oceanic and Atmospheric Administration

As part of the interagency National Integrated Heat Health Information System, NOAA launched Heat.gov in 2022, which is a website that provides clear, timely, and science-based information to understand and reduce the health risks of extreme heat. Heat.gov is intended for the public, decision-makers, and news media. This website provides real time updates regarding the percentage of the country is under extreme heat advisories, watches, and warnings. The information provided on the website includes heat forecasts from NOAA's National Weather Service, Department of Health and Human Services monthly Climate and Health Outlook, and CDC's Heat and Health Tracker.

Regarding heat monitoring and forecasting, NOAA issues outlooks for excessive heat 8-14 days, as well as 3-7 days in advance and provides hourly forecasts, advisories, watches and warnings when dangerous heat becomes likely or imminent.

Flood

The National Flood Insurance Program, Flood Insurance Rate Maps, Flood Insurance Study, and the Community Rating System are discussed in the Risk Assessment (Volume I: Section 3) under the Flood hazard. In addition to the NFIP and associated programs, the following are flood-related federal resources.

National Resources Conservation Service

The NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource or that experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance to clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures taken under EWP must be environmentally and economically sound and generally benefit more than one property.

Federal Emergency Management Agency Programs

FEMA resulted from the consolidation of five federal agencies that dealt with different types of emergencies. FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance. More information can be found in the Risk Assessment under the Flood hazard.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) plays a major role in a coordinated and complex system to reduce flood risks and provide water for hydropower generation, fish and wildlife enhancement, navigation, recreation, and other uses. Portland District's primary water management mission is to save lives and reduce property damage by reducing flood risks with measures both structural (such as dams) and non- structural (such as improving the natural function of floodplains).

Landslide

National Resources Conservation Service

The NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. Since flood events can trigger landslide events, the NRCS programs provide a nexus. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource or that experiences frequent flooding. The Emergency Watershed Protection Program provides technical and financial assistance to clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures taken under EWP must be environmentally and economically sound and benefit more than one property.

Volcano

U.S. Geological Survey

A major existing strategy to address volcanic hazards is to publicize and distribute volcanic hazard maps and information through USGS and state agencies, such as DOGAMI.

The volcanoes most likely to constitute a hazard to Oregon communities have been the subject of USGS research. Open-file reports address the geologic history of these volcanoes and lesser-known volcanoes in their immediate vicinity. These reports also cover associated hazards, the geographic extent of impacts, and mitigation strategies. They are available for the active volcanoes such as Mount St. Helens, the Three Sisters, Newberry Volcano, and Crater Lake. While there is not an Open-file reports for Mount Bachelor, there are other resource materials that provide considerable information.

Of note, after the 1980 eruption of Mount St. Helens, Congress provided increased funding that enabled the USGS to establish a volcano observatory for the Cascade Range. Located in Vancouver, Washington, the David A. Johnston Cascades Volcano Observatory was named for a USGS scientist killed at a forward observation post by the May 18, 1980, eruption (https://pubs.usgs.gov/fs/1997/fs165-97/fs165-97.pdf).

For more information, please refer to USGS at https://www.usgs.gov/programs/VHP.

Water Quality/Water Emergency

Environmental Protection Agency

According to the EPA, the Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. “Clean Water Act” became the Act’s common name with amendments in 1972.

The Water Quality Standards Regulation (40 CFR 131) establishes the requirements for states and tribes to review, revise and adopt water quality standards. It also establishes the procedures for EPA to review, approve, disapprove and promulgate water quality standards pursuant to section 303 I of the Clean Water Act.

Congress passed the [Safe Drinking Water Act (SDWA)]() in 1974 to protect public health, including by regulating public water systems. The EPA has established protective drinking water standards for more than 90 contaminants, including drinking water regulations issued since the 1996 amendments to SDWA that strengthen public health protection. Over 92 percent of the population supplied by community water systems receives drinking water that meets all health-based standards all the time. EPA requires community water systems to deliver a Consumer Confidence Report, also known as an annual drinking water quality report, to their customers. These reports provide Americans information about their local drinking water quality.

Wildfire

The proposed role of the federal land managing agencies, such as the U.S. Forest Service and the Bureau of Land Management, in the wildland/urban interface is diverse. Their roles include reducing fuel hazards on the lands they administer; cooperating in prevention and education programs; providing technical and financial assistance; and developing agreements, partnerships, and relationships with property owners, local protection agencies, states, and other stakeholders in wildland/urban interface areas. These relationships focus on activities before a fire occurs, which render structures and communities safer and better able to survive a fire.

For more information, refer to the joint USDI and USDA site, *Forest and Rangelands* at https://www.forestsandrangelands.gov/.

Federal Emergency Management Agency Programs

FEMA is directly responsible for providing fire suppression assistance grants and, in certain cases, major disaster assistance and hazard mitigation grants in response to fires. The role of FEMA in the wildland/urban interface is to encourage comprehensive disaster preparedness plans and programs, increase the capability of state and local governments, and provide for a greater understanding of F’MA's programs at the federal, state, and local levels.

Fire Suppression Assistance Grants

FEMA’s Fire Suppression Assistance Grants may be provided to a state only if the state has an approved hazard mitigation plan for the suppression of a forest or grassland fire that threatens to become a major disaster on public or private lands. These grants are provided to protect life and improved property, encourage the development and implementation of viable multi-hazard mitigation measures, and provide training to clarify F’MA's programs.

The grant may include funds for equipment, supplies, and personnel. A Fire Suppression Assistance Grant is the form of assistance most often provided by FEMA to a state for a fire. The grants are cost-shared with states. Once the federal grant money is provided to the state, it is passed along to local jurisdictions. This money would be passed along to Marion or Polk Counties to be applied to projects. The U.S. Fire Administration (USFA) provides public education materials addressing wildland/urban interface issues, and the U’FA's National Fire Academy provides training programs.

National Wildland/Urban Interface Fire Protection Program

Federal agencies can use the National Wildland/Urban Interface Fire Protection Program to focus on wildland/urban interface fire protection issues and actions. The Western Governors' Association can act as a catalyst to involve state agencies, as well as local and private stakeholders, with the objective of developing an implementation plan to achieve a uniform, integrated national approach to hazard and risk assessment and fire prevention and protection in the wildland/urban interface. The program helps states develop viable and comprehensive wildland fire mitigation plans and performance-based partnerships.

U.S. Forest Service

The U.S. Forest Service (USFS) implements a fuel-loading program to assess fuels and reduce hazardous buildup on federal forestlands.

The USFS has a fuel-loading program to assess fuels and reduce hazardous buildup on U.S. forestlands. The USFS is a cooperating agency and, it has an interest in preventing fires in the WUI, as fires often burn up the hills and into the higher elevation U.S. forestlands.

According to USFS *Wildland Fire* website, the USFS and other federal, tribal, state, and local government agencies work together to respond to tens of thousands of wildfires annually. Each year, an average of more than 73,000 wildfires burn approximately 7 million acres of federal, tribal, state, and private land and more than 2,600 structures.

The USFS recognizes the wildland fire management environment has profoundly changed. Longer fire seasons, bigger fires and more acres burned on average each year, more extreme fire behavior, and wildfire suppression operations in the WUI have become the norm. To address the challenges, the USFS and its federal, tribal, state, and local partners have developed and are implementing a *National Cohesive Wildland Fire Management Strategy* that has three key components: Resilient Landscapes, Fire Adapted Communities, and Safe and Effective Wildfire Response.

For more information, refer to https://www.fs.fed.us/managing-land/fire.

Bureau of Land Management (BLM)

The Bureau of Land Management (BLM) is responsible for “managing public lands for a variety of uses such as energy development, livestock grazing, recreation, and timber harvesting while ensuring natural, cultural, and historic resources are maintained for present and future use.” According to their website, the BLM manages 1/10 of the nation’s surface area and 30% of the nation's mineral and soils (https://www.blm.gov/about/our-mission).

In Oregon, BLM is responsible for fire protection for all federal agencies. They also provide fire protection on Oregon Department of State Lands (DSL) land and on some Oregon State Parks' lands. BLM has a memorandum of agreement with Oregon to provide support to the Rangeland Fire Protection Associations (RFPA) (Crouch, 2019).

There is a program through the BLM, called the Rural Fire Readiness Program. It's a separate cooperative agreement that a RFPA can sign with BLM; it removes them from the statewide memorandum of agreement with Oregon. The cooperative agreement provides more money to the RFPAs for training and equipment (Crouch, 2019). See the descriptions of Rangeland Fire Protection Associations, ODF, and the US Forest Service for additional information.

Firewise

Firewise is a program developed within the National Wildland/Urban Interface Fire Protection Program and is the primary federal program addressing interface fire. It is administered through the National Wildfire Coordinating Group whose extensive list of participants includes a wide range of federal agencies. The program is intended to empower local planners and decision makers. Through conferences and information dissemination, Firewise increases support for interface wildfire mitigation by educating professionals and the public about hazard evaluation and policy implementation techniques.

Firewise offers online wildfire protection information and checklists, as well as listings of other publications, videos, and conferences. The interactive home page allows users to ask fire protection experts questions, and to register for new information as it becomes available.

For more information on the Firewise program, contact Wildland/Urban Interface Fire Program C/o The National Fire Protection Association 1 Batterymarch Park, Quincy, MA 02269 and http://www.firewise.org.

FireFree Program

FireFree is a unique private/public program for interface wildfire mitigation involving partnerships among an insurance company and local government agencies. It is an example of an effective non-regulatory approach to hazard mitigation. Originating in Bend, Oregon the program was developed in response to that city's Skeleton Fire of 1996, which burned over 17,000 acres and damaged or destroyed 30 homes and other structures. Bend sought to create a new kind of public education initiative that emphasized local involvement. SAFECO Insurance Corporation was a willing collaborator in this effort.

The success of the program helped to secure $300,000 in FEMA "Project Impact" matching funds. By fostering local community involvement, FireFree also has the potential for building support for sound interface wildfire policy. For information on FireFree, contact: SAFECO Plaza T-8, Seattle, WA 98185, (206) 545-6188 https://www.firefree.org/

State Resources

Multi-Hazard

Statewide Planning Goals

There are 19 Statewide Planning Goals that guide land use in the State of Oregon. These became law via Senate Bill 100 in 1973. Goal 7, Areas Subject to Natural Disasters and Hazards, requires local governments to identify hazards and adopt appropriate safeguards for land use and development. Goal 7 advocates the continuous incorporation of hazard information in local land use plans and policies. The jurisdiction participating in this *2023 Salem NHMP* has approved comprehensive plans that include information pertinent to Goal 7. https://www.oregon.gov/lcd/OP/Pages/Goals.aspx

Oregon Department of Emergency Management

OEM is involved in many programs that mitigate the effects of natural hazards including the Hazard Mitigation Grant Program, co-sponsoring and participating in training workshops. Also, as part of its warning responsibilities, OEM notifies local public safety agencies and keeps them informed of potential and actual hazard events so prevention and mitigation actions can be taken.

Planning for Natural Hazards: Oregon Technical Resource Guide

This guide describes basic mitigation strategies and resources related to coastal hazards, floods, and other natural hazards, including examples from communities in Oregon. https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909

Oregon Department of Transportation

Oregon Department of Transportation (ODOT) travel information site, TripCheck, provides road conditions, weather information, and travel information. This website also provides information to help the public detour away from hazard areas during times of emergency. The TripCheck link also has road camera images to inform the public of road conditions prior to making a trip. https://tripcheck.com/

State Natural Hazard Risk Assessment

The risk assessment in the *2020 Oregon Natural Hazards Mitigation Plan* provides an overview of all the identified natural hazards in Oregon (in the State NHMP but not necessarily all the locally identified natural hazards) and identifies the most significant hazards in Oregon's recorded history. It has overall state and regional information and includes mitigation actions for the entire state.
https://www.oregon.gov/lcd/NH/Documents/Approved_2020ORNHMP_00_Complete.pdf

Oregon State Building Code Standards

The Oregon's Building Codes Division adopts statewide standards for building construction that are administered by the state, cities and counties throughout Oregon. The codes apply to new construction and to the alteration of, or addition to, existing structures. The following are hazard-specific standards:

- Six levels of design and engineering specifications that are applied to areas according to the expected degree of ground motion and site conditions that a given area could experience during an earthquake. There are site-specific seismic hazard reports required for projects involving critical facilities and special occupancy structures. The Dwelling Code incorporates prescriptive requirements for foundation reinforcement and framing connections based on the applicable seismic zone for the area.
- Building Codes standards (both residential and other codes) are set to withstand 80 mph winds.
- Building Codes standards (both residential and other codes) are set to withstand specific snow loads.
- Building Code standards for structures within the floodplain and in landslide areas.

Local building officials are responsible for enforcing these codes. Although there is no statewide building code for substandard structures, local communities have the option of adopting a local building code to mitigate hazards in existing buildings. Oregon Revised Statutes allow municipalities to create local programs to require seismic retrofitting of existing buildings within their communities. The building codes do not regulate public utilities or facilities constructed in public right-of-way, such as bridges.

The *2017 Oregon Residential Special Code* (*ORSC*) contains requirements for one- and two-family dwellings (https://codes.iccsafe.org/content/document/1018?site_type=public).

The *2019 Oregon Structural Special Code* (*OSSC*) contains provisions for grading and site preparation for the construction of building foundations (https://codes.iccsafe.org/content/OSSC2019P1).

Roadway Maintenance

ODOT is responsible for performing precautionary measures to maintain the safety and operability of major roads during storm conditions. The road maintenance programs are designed to provide the best use of limited resources to maximize the movement of traffic within the community during inclement weather.

During storm events, most agencies at the county and city level focus on clearing major arterial and collector streets first, and then respond to residential connector streets, school zones, transit routes, and steep residential streets as resources become available. The state, counties, and cities, may have agreements, including mutual aid agreements, about road maintenance responsibilities during day-to-day operations and who does what in storm situations. In general, highways receive more attention. For those routes on the National Highway System network, primary interstate expressways, and primary roadways will be cleared more quickly and completely than other roads.

Air Quality

Department of Environmental Quality

DEQ is a regulatory agency with the responsibility to protect and enhance the quality of Oregon's environment. DEQ 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."

Department of Energy

The Oregon Department of Energy (ODOE) partners with other Oregon state agencies to develop policy options to reduce greenhouse gas emissions. The agency also provides technical assistance for greenhouse gas planning and mitigation programs in other state agencies, cities, and counties.

Planning for Natural Hazards: Oregon Technical Resource Guide

This guide describes basic mitigation strategies and resources related to coastal hazards, floods, and other natural hazards, including examples from communities in Oregon. https://scholarsbank.uoregon.edu/xmlui/handle/1794/1909

Drought

Water Supply Availability Committee and Drought Readiness Council

Oregon Revised Statute (ORS) 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 interagency groups to evaluate water supply conditions, and to help assess and communicate potential drought related impacts, the Water Supply Availability Committee and the Drought Readiness Council.

The Water Supply Availability Committee (WSAC) is a technical committee chaired by the Oregon Water Resources Department (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 release of NRCS Water Supply Outlook reports for that year (second week of the month beginning as early as January) to assess conditions. The following are indicators used by the WSAC for evaluating drought conditions as identified in the OEM *Comprehensive Emergency Management Plan, Incident Annex 01 Drought*:

- 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 Nino, La Nina)
- Storage in key reservoirs
- Soil and fuel moisture conditions
- NRCS Surface Water Supply Index

The other group that Oregon relies upon to evaluate water conditions is the Drought Readiness Council (DRC), which is co-chaired by the OWRD and OEM. The council consists of state agencies with natural resources management, public health, or emergency management expertise. The role of the DRC is to review local requests for assistance and make recommendations to the Governor regarding the need for state drought declarations.

Earthquake

Business Oregon, Infrastructure Finance Authority

Business Oregon's Infrastructure Finance Authority supports the Seismic Rehabilitation Grant Program (SRGP). This program is a State of Oregon competitive grant program that provides funding for the seismic rehabilitation of critical public buildings, particularly public schools and emergency services facilities. Public K-12 school districts, community colleges, and education service districts are eligible for the grant program. For emergency services facilities, the emphasis is on first responder buildings. This includes hospital buildings with acute inpatient care facilities, fire stations, police stations, sheriff's offices, 9-1-1 centers, and Emergency Operations Centers (EOCs).

Oregon Department of Emergency Management

September is National Preparedness Month, a time to raise awareness about preparing for disasters and emergencies before they happen. In addition, the Great Oregon ShakeOut occurs in October. OEM coordinates activities such as earthquake drills related to Great Oregon ShakeOut and encourages individuals to prepare for earthquakes by strapping down computers, heavy furniture and bookshelves in homes and offices.

Extreme Heat

Oregon Health Authority

Heat-related deaths and illness are preventable, yet annually many people succumb to extreme heat. The Oregon Health Authority (OHA) website provides accessible resources for members of the public, local health departments, and other organizations to assist ongoing outreach efforts to those most vulnerable to extreme heat events.

Flood

Oregon Water Resources Department

The OWRD is the state authority for dam safety with specific authorizing laws and implementing regulations. OWRD coordinates on but does not directly regulate the safety of dams owned by the United States or most dams used to generate hydropower. The OWRD has been striving to inspect the over 900 dams under its authority. The Dam Safety 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.

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 Dam Safety Program also coordinates with the National Weather Service and the OEM on severe flood potential that could affect dams and other infrastructure.

State of Oregon Removal/Fill Law

The Oregon Removal/Fill Law, which is administered by the Oregon Department of State Lands (DSL), requires a permit for activities that would remove or fill 50 cubic yards or more of material in waters of the state (e.g., streams, lakes, wetlands). The City of Salem is a cooperating partner with DSL by maintaining waterway and wetlands maps for public use, referring affected owners to DSL, and coordinating permit activities.

Oregon's Wetlands Protection Program

Oregon's Wetlands Protection Program was created in 1989 to integrate federal and state rules concerning wetlands protection with the Oregon Land Use Planning Program. The Wetlands Program has a mandate to work closely with local governments and DSL to improve land use planning approaches to wetlands conservation. A local wetlands inventory is one component of that program. DSL also develops technical manuals, conducts wetlands workshops for planners, provides grant funds for wetlands planning, and works directly with local governments on wetlands planning tasks. Salem has compiled a local wetlands inventory for lands where development is likely to occur and identified those wetlands that provide the greatest benefit to the community. These significant wetlands are commonly found in flood-prone areas.

Silver Jackets

The Silver Jackets program is a joint state-federal-local flood mitigation subcommittee, which is tied to a national USACE initiative. In Oregon, Silver Jackets provides a forum where DLCD, DOGAMI, OEM, USACE, FEMA, U.S. Geological Survey (USGS), and additional federal, state and sometimes local and Tribal agencies can come together to collaboratively plan and implement flood mitigation, optimizing multi-agency utilization of federal assistance by leveraging state/ local/ Tribal resources, including data/ information, talent and funding, and preventing duplication among agencies.

Oregon established Silver Jackets as a subcommittee to the Interagency Hazard Mitigation Team (IHMT), with the primary intents of strengthening interagency relationships and cooperation, optimizing resources, and improving risk communication and messaging. The Oregon Silver Jackets act as a catalyst in developing comprehensive and sustainable solutions to state flood hazard challenges.

For more information regarding the Oregon Silver Jackets, refer to https://www.iwr.usace.army.mil/Silver-Jackets/State-Teams/Oregon/.

Landslide

Oregon Department of Geology and Mineral Industries

Regarding current landslide warning system in Oregon, DOGAMI's *History of Oregon Landslide Warning System* (2021) states,

> The current landslide warning system developed over years with additions and modifications to the language and changes to system responsibilities. As of 2019, a notice about the potential for landslides or debris flows starts with NWS, by using unique language in their flood watch products. After receiving NWS flood watches

with landslide language via an RSS feed, DOGAMI posts on its website an alert message including a link to the NWS flood watch message, sends out a press release to the affected areas, and responds to media inquiries. OEM broadcasts the alert through the Oregon Emergency Response System (OERS). ODOT turns on highway warning signs at the appropriate locations and posts alerts on the TripCheck website (https://tripcheck.com/) The current process was outlined in a June 2018 DOGAMI internal communication document on landslide/debris flow alerts, developed by Bill Burns and then DOGAMI Communications Director Ali Hansen. Figure 7 graphically depicts the current communication process.

Volcano

Oregon Department of Geology and Mineral Industries

A major existing strategy to address volcanic hazards is to publicize and distribute volcanic hazard maps and information through DOGAMI and USGS, as discussed above.

The volcanoes most likely to constitute a hazard to Oregon communities have been the subject of DOGAMI and USGS research. Open-file reports address the geologic history of these volcanoes and lesser-known volcanoes in their immediate vicinity. These reports also cover associated hazards, the geographic extent of impacts, and mitigation strategies. They are available for the active volcanoes such as Mount St. Helens, the Three Sisters, Newberry Volcano, and Crater Lake. While there is not an Open-file reports for Mount Bachelor, there are other resource materials that provide considerable information.

For more information, refer to DOGAMI at https://www.oregongeology.org/volcano/volcanoes.htm.

Water Quality/Water Emergency

Oregon Health Authority

Access to safe drinking water is essential to human health. Oregon Health Authority (OHA) *Drinking Water Services* helps to keep drinking water safe for Oregonians. The Drinking Water Services administers and enforces drinking water quality standards for public water systems in the state of Oregon. It also focuses resources in the areas of highest public health benefit and promotes voluntary compliance with state and federal drinking water standards with an emphasis on prevention of contamination through source water protection. They also provide technical assistance to water systems and provides water system operator training.

Oregon Department of Environmental Quality

DEQ uses water quality standards to assess whether the quality of the state's rivers and lakes is adequate for fish and other aquatic life, recreation, drinking, agriculture, industry and other uses. DEQ also uses the standards as regulatory tools to prevent pollution of the state's waters. More information regarding DEQ's role in water quality can be found at https://www.oregon.gov/deq/wq/Pages/default.aspx.

Included in DEQ's water quality protection is Total Maximum Daily Load (TMDL), which is a clean water plan, used to clean up polluted water so that it meets state water quality standards. A TMDL defines the amount of a pollutant that can be present in a waterbody without causing water quality criteria to be exceeded. In December 2002, Oregon's Environmental Quality Commission adopted Oregon Administrative Rule (OAR) Chapter 340, Division 42, commonly referred to as the TMDL rule. The rule defines DEQ's responsibilities for developing, issuing, and implementing TMDLs as required by the CWA.

A Water Quality Management Plan (WQMP) is one of the 12 TMDL elements called for in OAR 340-042-0040. The WQMP is a general plan and framework for implementation of the TMDL. The WQMP framework is designed to work in conjunction with detailed plans and analyses provided in sector-specific or source-specific implementation plans. TMDLs, the WQMP, and associated implementation plans and activities are designed to restore water quality to comply with water quality standards. In this way designated beneficial uses, such as aquatic life, drinking water supplies, and water contact recreation, will be protected.

The EPA approved the Willamette Basin TMDL plan on September 29, 2006. Included in this plan is the *Willamette Basin Water Quality Management Plan*.

Water Supply Availability Committee and Drought Readiness Council

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 interagency 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 (DRC).

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 DRC, which is co-chaired by the OWRD and OEM, consists of state agencies with natural resources management, public health, or emergency management expertise. The role of the DRC is to review local requests for assistance and make recommendations to the Governor regarding the need for state drought declarations.

Oregon Water Resources Department

OWRD serves the public by practicing and promoting responsible water management by directly addressing Oregon's water supply needs; in addition to, restoring and protecting stream flows and watersheds to ensure the long-term sustainability of Oregon's ecosystems, economy, and quality of life. OWRD has several programs including water rights; groundwater and wells; streams, lakes and dams; drought, and wildfire recovery. For more information on OWRD programs, refer to https://www.oregon.gov/owrd/programs/Pages/default.aspx.

OWRD evaluates applications for Aquifer Storage and Recovery authorization for proposed projects and their potential effects on the groundwater resource and other water users. ASR-related statutes (ORS 537.531 to 537.534) and rules (OAR 690-350-010 to 690-350-030) provide a legal framework for water users to store water underground during times of low demand and then recover it through wells during high demand periods. Extensive water quality and water quantity monitoring and reporting is part of all projects. Water quality issues are addressed through coordination with DEQ and OHA Drinking Water Services, according to OWRD Aquifer Storage and Recovery program.

Wildfire

Oregon Revised Statute 215.730

ORS 215.730, Additional Criteria for Forestland Dwellings, provides criteria for approving dwellings located on lands zoned for forest and mixed agriculture/forest use. Under its provisions, county governments must require, as a condition of approval, that single-family dwellings on lands zoned as forestland meet the following requirements:

1. Dwelling has a fire retardant roof;
2. Dwelling will not be sited on a slope of greater than 40 percent;
3. Evidence is provided that the domestic water supply is from a source authorized by OWRD and not from a Class II stream as designated by the State Board of Forestry;
4. Dwelling is located upon a parcel within a fire protection district or is provided with residential fire protection by contract;
5. If dwelling is not within a fire protection district, the applicant provides evidence that the applicant has asked to be included in the nearest such district;
6. If dwelling has a chimney or chimneys, each chimney has a spark arrester; and
7. Dwelling owner provides and maintains a primary fuel-free break and secondary break areas on land surrounding the dwelling that is owned or controlled by the owner.

If a governing body determines that meeting the fourth requirement is impractical, local officials can approve an alternative means for protecting the dwelling from fire hazards.

Oregon Revised Statute 477.015-061

Provisions in ORS 477.015-061, Urban Interface Fire Protection, were established through efforts of the ODF, the Office of the State Fire Marshal, fire service agencies from across the state, and the Commissioners of Deschutes, Jefferson, and Jackson Counties. It is innovative legislation designed to address the expanding interface wildfire problem within ODF Fire Protection Districts. Full implementation of the statute will occur on or after January 1, 2002. The statute does the following:

1. Directs the State Forester to establish a system of classifying forestland-urban interface areas;
2. Defines forestland-urban interface areas;
3. Provides education to property owners about fire hazards in forestland-urban interface areas. Allows for a forestland- urban interface county committee to establish classification standards;
4. Requires maps identifying classified areas to be made public;
5. Requires public hearings and mailings to affected property owners on proposed classifications;
6. Allows property owners appeal rights;
7. Directs the Board of Forestry to promulgate rules that set minimum acceptable standards to minimize and mitigate fire hazards within forestland-urban interface areas; and

8. Creates a certification system for property owners meeting acceptable standards. Establishes a $100,000 liability limit for cost of suppressing fires if certification requirements are not met.

Senate Bill 360

Senate Bill 360, passed in 1997, is state legislation put in place to address the growing wildland/urban interface problem. The bill has three purposes:

1. To provide an interface fire protection system in Oregon to minimize cost and risk and maximize effectiveness and efficiency;
2. To promote and encourage property owners' efforts to minimize and mitigate fire hazards and risks; and
3. To promote and encourage involvement of all levels of government and the private sector in interface solutions.

The bill has a five-year implementation plan that includes public education and outreach, and the development of rules, standards, and guidelines that address landowner and agency responsibilities. The success of Senate Bill 360 depends upon cooperation among local and regional fire departments, fire prevention cooperatives, and the ODF, which means that interagency collaboration, is vital for successful implementation of the bill. This cooperation is important in all aspects of wildland firefighting. Resources and funding are often limited, and no single agency has enough resources to tackle a tough fire season alone. The introductory language of Senate Bill 360 states, "The fire protection needs of the interface must be satisfied if we are to meet the basic policy of the protection of human life, natural resources, and personal property. This protection must be provided in an efficient and effective manner, and in a cooperative partnership approach between property owners, local citizens, government leaders, and fire protection agencies."

Senate Bill 762

In 2021, the Oregon Legislature passed Senate Bill 762 (SB-762) which required ODF to develop a new statewide wildfire risk map updating the current use of the 2018 Quantitative Wildfire Risk Assessment. ODF develop administrative rules with input from a 26-member rulemaking advisory committee. The rules, adopted by the Board of Forestry, establish the criteria by which the map is developed, updated, and maintained. The rules also included the following:

- Implement five statewide wildfire risk classes of extreme, high, moderate, low and no risk, based on weather, climate, topography, and vegetation.
- Develop a process in which a property owner may appeal a designation of wildfire risk class.
- Determine a process in which a property owner is notified of risk assignment of high or extreme.
- Develop maintenance criteria for the map.

The new Wildfire Risk Map was released on June 30, 2022, but was withdrawn for further consideration of public comment. When the map is re-released, it will show what properties in Oregon fall within the WUI, as defined by the Board of Forestry in rule in 2021. Oregon State University developed the map based on the rules adopted by the board and the best data available.

The map will show the assigned risk classification for every tax lot in the state. Those that are both within the WUI and classified as high or extreme risk will receive written notification from ODF and may be subject to future changes to defensible space and home building codes. There may also be changes to statewide land use planning programs and local plans and zoning codes.

Until the map is re-released the statewide wildfire risk maps presented through Oregon Wildfire Risk Explorer are from the 2018 Quantitative Wildfire Risk Assessment. This is also the dataset used by the DOGAMI geologic hazard analysis performed for this NHMP update in 2022.

SB 762 also established new electric utility system mandates to identify and assist in mitigating wildfire risk. Sections 1 through 6 of the bill impact electric systems and the Public Utility Commission (PUC) directly and indirectly. Sections 3 – 5 focuses on requiring both investor-owned utilities (IOUs) and consumer-owned utilities (COUs) to operate under a risk-based wildfire protection plans. The IOUs must submit plans annually to the PUC for review and approval. The COUs must submit copies to the PUC of their wildfire mitigation plans once they have been approved by their governing body. As of July 7, 2022, the following Salem utilities have current wildfire mitigation plans.

- Investor-owned utilities: Portland General Electric and PacificCorp
- Consumer-owned utilities: Salem Electric

Oregon Department of Forestry

ODF is involved with local fire chiefs and local fire departments to provide training. Local firefighters can get a range of experience from exposure to wildland firefighting. Local firefighters can also obtain their red card (wildland fire training documentation) and attend extensive workshops combining elements of structural and wildland firefighting, defending homes, and operations experience (Wolf, 2001). ODF has been involved with emergency managers to provide support during non-fire events and for years, ODF has worked with industrial partners (big timber companies) to share equipment in the case of extremely large fires (Wolf, 2001).

Local Resources

Multi-Hazard

Community Emergency Response Team

The Community Emergency Response Team (CERT) program educates volunteers about disaster preparedness for the hazards that may occur where they live. Salem has a dedicated and respected CERT team, who trains volunteers to assist their communities when a disastrous event overwhelms or delays the community’s professional response.

National Weather Service and Salem Emergency Management

The NWS can predict severe weather events that may trigger prolonged or flash flood events, landslide, and other severe weather. The NWS can issue notices to response agencies and to the public via television, radio, internet and Weather Radios (formerly Tone Alert Radios) when the potential for flooding is likely, for example. Salem Emergency

Management, Salem Police, and the Salem Fire and Ambulance District coordinate with NWS when notices may be required to inform response agencies and the public of potential hazard events.

This description is excerpted from the *Salem Emergency Management Plan* (2020).

> This Emergency Management Plan is an all-hazard plan that describes how the City of Salem will organize and respond to emergencies and disasters in the community. It is based on, and is compatible with, Federal, State of Oregon, and other applicable laws, regulations, plans, and policies, including Presidential Policy Directive 8, the National Response Framework, Oregon Office of Emergency Management Plan, and both Marion and Polk County Emergency Operations Plans.
>
> Response to emergency or disaster conditions in order to maximize the safety of the public and to minimize property damage is a primary responsibility of government. It is the goal of the City of Salem that responses to such conditions are conducted in the most organized, efficient, and effective manner possible. To aid in accomplishing this goal, the City of Salem has, in addition to promulgating this plan, formally adopted the principles of the National Incident Management System, including the Incident Command System and the National Response Framework.
>
> Consisting of a Basic Plan, Functional Annexes aligned with both Marion and Polk County Emergency Support Functions, and Incident Annexes, this Salem Emergency Management Plan provides a framework for coordinated response and recovery activities during a large-scale emergency. The plan describes how various agencies and organizations in the City of Salem will coordinate resources and activities with other Federal, State, local, tribal, and private-sector partners.

Salem Climate Action Plan 2021 and Community Greenhouse Gas Inventory

Since the last NHMP update, Salem developed the *Salem Climate Action Plan 2021* that outlines strategies and actions to reduce Greenhouse Gas emissions and increase climate resiliency in our community. Through the development of the *Salem Climate Action Plan 2021*, it was determined that Salem's projected climate impacts will include three main categories: warming temperatures, changes in precipitation patterns, and increased risk of wildfires. Many of the strategies in the CAP are designed to help the community adapt to impacts and build resiliency for the future. The strategies seek to do the following:

- Expand the urban tree canopy and access to green spaces
- Create a climate related education and outreach program
- Create a network of indoor gathering places that can serve as community centers during times of need
- Engage underserved populations in co-creating resilient solutions
- Strengthen the local economy

Salem provides information online regarding how, on an individual basis, the community can help combat climate change including looking at transportation alternatives, energy efficiency efforts at home, waste reduction (especially food waste), food choices, and tree planting to help minimize urban heat islands.

Salem Area Comprehensive Plan

The *Salem Area Comprehensive Plan* (2022), is the long-range plan for guiding development in the Salem-Keizer urban area for the next 20 years. The Natural Resource goal of the Salem Area Comprehensive Plan is "To conserve open space, protect natural, historic, cultural and scenic resources, and to protect life and property from natural disasters and hazards."

Salem Community Development

The Community Development Department helps develop a livable city through the following divisions: Building & Safety, Library, Planning, and Neighborhood Enhancement. The Salem Revised Code (SRC) includes Title V, Community Development Standards, which addresses building code, housing code, historic preservation, and comprehensive planning. The SRC Title X, Unified Development Code is the city's zoning ordinance, which addresses natural hazards including floodplain standards (Chapter 601, Floodplain Overlay Zone).

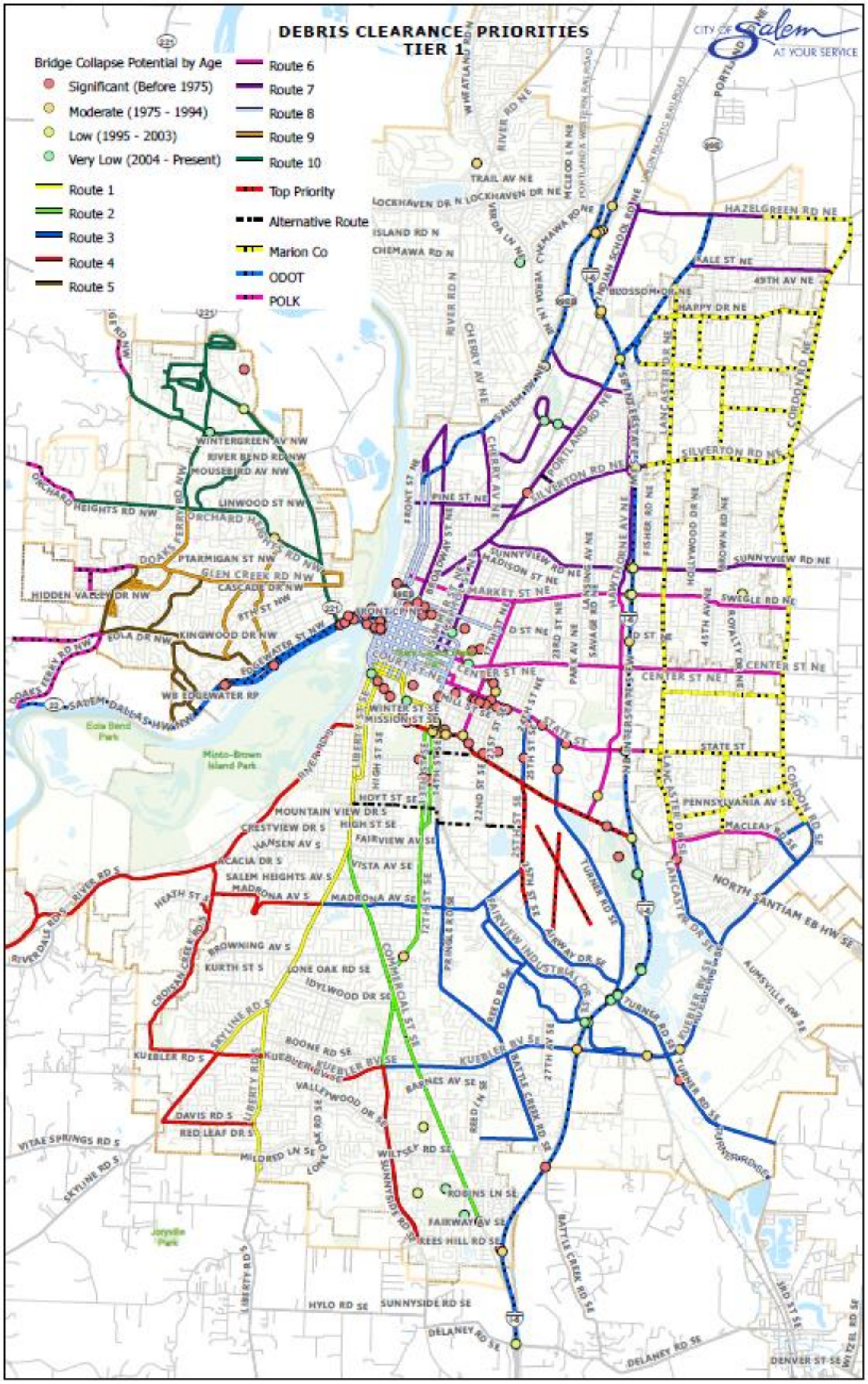
Salem Community Forestry Strategic Plan

The Salem's *Community Forestry Strategic Plan* (2013) recognizes that trees provide multiple economic, environmental, and social benefits. Due to all the advantages trees provide, Salem's Public Works decided to investigate ways to improve the city's community forest, with an emphasis on non-regulatory approaches and incentives. The plan establishes six goals and specific actions, priorities, and partnerships needed to achieve the goals. Goal 5 includes the development and implementation of a Community Forestry Management Plan that will help establish industry appropriate best management practices, standards, and protocols for tree care, risk and hazard reduction, and storm/hazard tree response, removal and replanting.

Salem Public Works – Transportation Routes

Salem's Public Works Department plans, constructs and maintains the infrastructure to meet the needs of Salem. Since the *2017 Salem NHMP*, the city has identified and designated priority transportation routes through a 2020 amendment to their Transportation System Plan. In addition, a bridge prioritization inventory based on major lifeline routes including state highways, routes, and major road arteries was also established. Salem's priorities focus on routes between Interstate I-5, Salem Health Hospital, and Salem Municipal Airport. The following map shows priority routes and bridge locations. Salem prioritizes improvement needs based on sufficiency rating (an overall score assigned to each bridge during their routine inspections – every 2 years) as well as average daily trip calculations.

Figure 60 Salem Disaster Priority Routes and Bridge Locations



Source: City of Salem Public Works

Salem Transportation System Plan (TSP)

The Salem *Transportation System Plan* (2020) provides a framework of goals, objectives, and policies that guides Salem's transportation system and recommends how Salem invest its resources in future transportation programs and infrastructure to meet anticipated travel demands. The TSP includes the following paragraph related to critical routes:

The City's arterial street system connects people to critical facilities as well as providing emergency response and evacuation routes in the event of natural hazards. Planning for and maintaining a robust network of critical routes supports the health and safety of the community. Identification of transportation improvement projects for both existing and new facilities should take into consideration the function of the street as a critical route for emergency management purposes. Data available to support this analysis includes identification of street segments that are prone to flooding and information gained through ridge inspection reports. Future transportation projects should consider opportunities to reduce the potential for critical routes to be blocked during major floods or other natural hazards.

Santiam Water Control District, Council of Water Leaders

The Council of Water Leaders (CWL) was created in 2022 to help address urgent water resource challenges in the North Santiam Watershed and provide a forum for increasing communication and coordination amongst decision-makers and other leaders on important issues in the North Santiam Watershed. CWL holds quarterly meetings and an annual symposium.

The CWL uses available science to develop long-term solutions to water management issues, such as the following:

- Emergency planning
- Post-fire recovery
- Drought contingency planning
- Water quantity (flow restoration and flow management)
- Water quality (source water protection and Willamette River mercury total maximum daily load (TMDL))
- Riparian and aquatic habitat restoration

Other Existing Strategies and Programs

Existing strategies and programs at the state level are usually performed by the Oregon Public Utility Commission (OPUC), Building Code Division (BCD), ODF, OEM, and the Oregon Department of Transportation.

The Oregon Emergency Response System (OERS) coordinates and manages state resources in response to natural and technological emergencies and civil unrest involving multi-jurisdictional cooperation between all levels of government and the private sector (https://www.oregon.gov/oem/emops/Pages/OERS.aspx).

Oregon Public Utility Commission ensures operators manage, construct and maintain their utility lines and equipment in a safe and reliable manner. These standards are listed on this website: http://www.puc.state.or.us/PUC/safety/index.shtml. OPUC promotes public education and requires utilities to maintain adequate tree and vegetation clearances from high voltage utility lines and equipment.

Drought

North Santiam Watershed Drought Contingency Plan

Since the last NHMP update, Salem participated in the development of the North Santiam Watershed Drought Contingency Plan (NSDCP). The NSDCP was developed by the North Santiam Watershed Task Force to foster a collaborative and non-regulatory approach to drought planning, monitoring, and response within the watershed. The goal of the NSDCP is to build long-term resiliency to drought to minimize impacts to the communities, local economies, and the critical natural resources within the watershed. The NSDCP addresses the entire North Santiam watershed, in addition to, users outside the basin, such as City of Salem. The NSDCP was accepted in April 2018 by the Bureau of Reclamation.

Salem and Santiam Water Control District are sponsoring partners for the Bureau of Reclamation 2022 WaterSMART Drought Contingency Planning grant, which has funded an update to the NSDCP. The NSDCP update is aimed at continuing to build long-term resiliency to drought in the North Santiam Watershed. This update process began in November 2022 and is anticipated to be completed sometime in 2024.

Earthquake

City of Salem, Emergencies and Disaster Preparedness

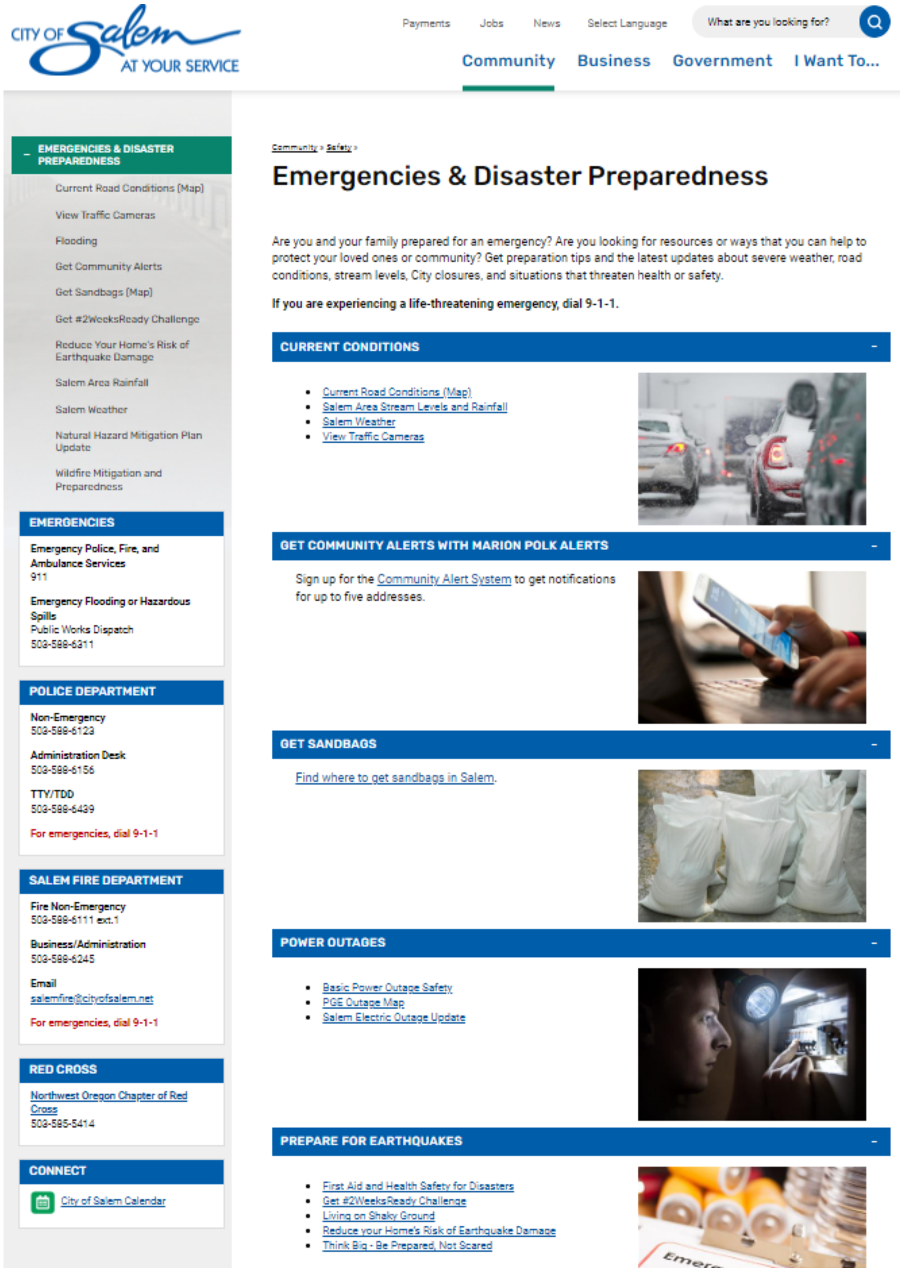
An individual's level of preparedness for an earthquake is minimal as perception and awareness of earthquakes are low. To help community members, Salem's Emergencies & Disaster Preparedness website shown, in part, in Figure 61 above, provides resources that will aid in individual's preparing for a natural hazard event, including earthquakes. Strapping down heavy furniture, water heaters and expensive personal property as well as having earthquake insurance, is a step towards earthquake mitigation.

In November 2017, Salem voters passed General Obligation Bond Measure 24-432 for $18.6 million to address seismic, safety, accessibility and system improvements to the Salem Public Library.

In November 2022, Salem voters passed a $300 million community improvement bond, that will fund street upgrades, sidewalk construction and repair, construction of bicycle facilities, replacement of old fire engines and equipment, updating information technology and cybersecurity tools, acquiring property for future affordable housing developments, fire stations, and two branch libraries; and complete earthquake safety upgrades to the Civic Center.

The Civic Center was built 50 years ago without seismic improvements. To meet current earthquake standards bond funding will be used to reinforce all three buildings which would allow visitors and staff exit options in the event of an earthquake. Funds would be used to replace and support skylights, windows, roofs and other systems, with abatement of hazardous materials and restoration of areas impacted by structural work.

Figure 61 Salem Emergencies & Disaster Preparedness Webpage (part)



Source: City of Salem

Salem-Keizer Public Schools

Salem-Keizer Public Schools conduct earthquake drills regularly throughout Oregon and teach students how to respond when an earthquake event occurs.

The Salem and City of Keizer voters approved a 2018 bond measure that, in part, approved improvements safety and security in the Salem-Keizer School District. Included in this bond measure included:

Seismic Renovations - $67M

- Address areas rated very high-risk for earthquake collapse
- Design additions constructed under the bond to re-occupancy standard, which means the structure could be used as a community shelter

The school district's bond implementation plan notes that 24 school district buildings have received seismic upgrades since the 2018 bond was approved. For more information, the Salem-Keizer Public Schools Bond Project website provides a construction and improvement overview by year and school.

As noted in the *2017 Salem NHMP*, seismic retrofit grant awards per Oregon's Seismic Rehabilitation Grant Program were funded to retrofit these Salem-Keizer Public Schools: Richmond Elementary and Four Corner Elementary.

Flood

Salem Community Development

Community participation in the NFIP requires the adoption and enforcement of a local floodplain management ordinance that controls development in the floodplain. Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent.

Flood Management Plan

Resulting from the *2017 Salem NHMP* mitigation strategy, the city created this floodplain management plan. The Salem *Floodplain Management Plan* (2018) identifies flood-related hazards and establishes an action plan for how to mitigate those hazards. Goals of the plan include: 1) develop and implement mitigation activities to protect human life; 2) protect existing buildings and infrastructure as well as future development from the impacts of natural hazards; 3) strengthen communication and coordination of public and private partnerships and emergency services among local, county, and regional governments and the private sector; and 4) enhance economic resilience to reduce the impact on the local economy.

Goal 5: Preserve and rehabilitate natural systems to serve natural hazard mitigation functions and protect natural resources.

Stormwater Master Plan

The Salem *Stormwater Master Plan* (2020), is a detailed part of the Salem Area Comprehensive Plan. The plan includes three major elements: (1) descriptions of the drainage basin for each major creek system; (2) a Drainage System Improvement Plan; and (3) a Stormwater Management Program Plan

As the *Stormwater Master Plan* (2020) indicates, several of Salem's major creek systems are in multiple jurisdictions. The drainage basins for most creek systems within Salem originate in rural areas outside the UGB including Battle, Croisan, Glenn-Gibson, Little Pudding, Mill, and Pettijohn-Laurel. Although most Salem creeks discharge into the Willamette River within the UGB, there are a few creek systems that can affect downstream communities that are not located along the Willamette River. These include Battle Creek discharges into Mill Creek near the City of Turner; Claggett Creek discharges near the City of Keizer; and Little Pudding River discharges into the Willamette River near Canby.

Salem is currently undergoing a process to update its *Stormwater Master Plan* (2020). One key issue affecting the plan's policies relates to how flood inundation data may be used for floodplain management.

In Salem's 2000 Stormwater Master Plan, 12 stormwater drainage basins were evaluated. The evaluation concluded additional stormwater infrastructure was not required to accommodate current and future growth in three basins—Lower Claggett Creek, Pettijohn Laurel Creek, and Willamette Slough basins—a conclusion that will be carried forward in the updated Stormwater Master Plan. Draft basin plans for the following have been completed:

- Battle Creek Basin Plan, September 2019
- Mill Creek Basin Plan, September 2019
- Pringle Creek Basin Plan, September 2019

The order of progression for completing plans for the remaining six basins are as follows: Glenn Gibson Basin, West Bank Basin (Willamette River), Upper Claggett Creek Basin, Croisan Creek Basin, Little Pudding Basin, and East Bank Basin (Willamette River).

Elevation Certificate Maintenance

Elevation certificates are administered by Salem's Public Works Department. The certificates are required for buildings constructed in the floodplain to demonstrate that the building is elevated adequately to protect it from flooding. The elevation certificate is an important administrative tool of the NFIP. It is used to determine the proper flood insurance premium rate; it can be used to document elevation information necessary to ensure compliance with community floodplain management regulations; and it may be used to support a request for a Letter of Map Amendment (LOMA), or Letter of Map Revision based on fill (LOMR-F). City of Salem has elevation certificates on file for many developed properties.

Water Quality/Water Emergency

City of Salem, Water Advisory Information

To help community members to understand and prepare for a water emergency, Salem's Public Works website provides information about algae watches, water advisories, and what is involved to ensure Salem's water is safe to drink. Salem monitors conditions in the watershed throughout the year and the website describes the different water monitoring levels that could be seen as the water in the North Santiam River changes. If conditions warrant a water advisory, Salem will let the community know through the Salem Community Alert System and the drinking water webpage, through local media, and posts on the City of Salem Facebook and Twitter social media accounts.

Salem Geren Island Water Treatment Facility

Salem invested over $50 million for the design and construction of a state-of-the art ozone treatment facility at Geren Island to ensure the community has safe and resilient drinking water long into the future, according to Salem's Drinking Water Treatment program.

In May 2018, water quality samples revealed that harmful algal blooms (cyanotoxins) were detected in Salem's drinking water distribution system, above a Health Advisory Level for the first time. In response, a drinking water advisory was issued, based upon the level of cyanotoxins detected, to vulnerable populations in Salem. In addition to collaborative water quality monitoring with USGS, Eugene Water and Electric Board, and USACE, to address the issue, Salem took steps to establish an ozone treatment system at Geren Island. The ozone treatment system, in full operation in 2022, removes algal toxins as well as contaminants caused by wildfires, according to the Salem's *Annual Water Quality Report 2022*.

North Santiam Watershed Drought Contingency Plan

Since the last NHMP update, Salem participated in the development of the North Santiam Watershed Drought Contingency Plan (NSDCP), which was accepted in April 2018 by the Bureau of Reclamation. The NSDCP was developed by the North Santiam Watershed Task Force to foster a collaborative and non-regulatory approach to drought planning, monitoring, and response within the watershed. The goal of the NSW DCP is to build long-term resiliency to drought to minimize impacts to the communities, local economies, and the critical natural resources within the watershed. The NSDCP addresses the entire North Santiam watershed, in addition to, users outside the basin, such as City of Salem. The plan provides framework for drought monitoring, asset vulnerability, and other conditions resulting from drought. Mitigation actions are provided to reduce risks and impacts before a drought, response during a drought, and collaboration for promoting an efficient response to drought.

According to the NSDCP, low streamflow is identified at Salem's intake on the North Santiam River as a vulnerability (meaning the ability of the intake to divert water under low flow conditions is limited). Therefore, the plan identifies 7-day rolling average flows in the as one indicator of North Santiam Watershed stage 6 drought. Recommended responses to the drought stages fall into the following categories: conservation messaging, public education, and outreach; monitoring and evaluation; water rights management; water conservation; and emergency responses. If a drought is declared in Marion County, Salem will do the following:

- Communicate with customers about the drought declaration and the status of Salem's water supply via the city website, as well as encourage water conservation.
- Communicate with the NSDCP Task Force and take appropriate actions as outlined in the NSDCP.
- Implement the appropriate stage of water curtailment if the drought declaration coincides with an identified curtailment trigger.

Salem and Santiam Water Control District are sponsoring partners for the Bureau of Reclamation 2022 WaterSMART Drought Contingency Planning grant, which has funded an update to the NSDCP. The NSDCP update is aimed at continuing to build long-term resiliency to drought in the North Santiam Watershed. This update process began in November 2022 and is anticipated to be completed sometime in 2024.

Santiam Water Control District, Council of Water Leaders

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- Emergency planning
- Post-fire recovery
- Drought contingency planning
- Water quantity (flow restoration and flow management)
- Water quality (source water protection and Willamette River mercury total maximum daily load (TMDL))
- Riparian and aquatic habitat restoration

Salem Clean Streams, Clear Choices Initiative

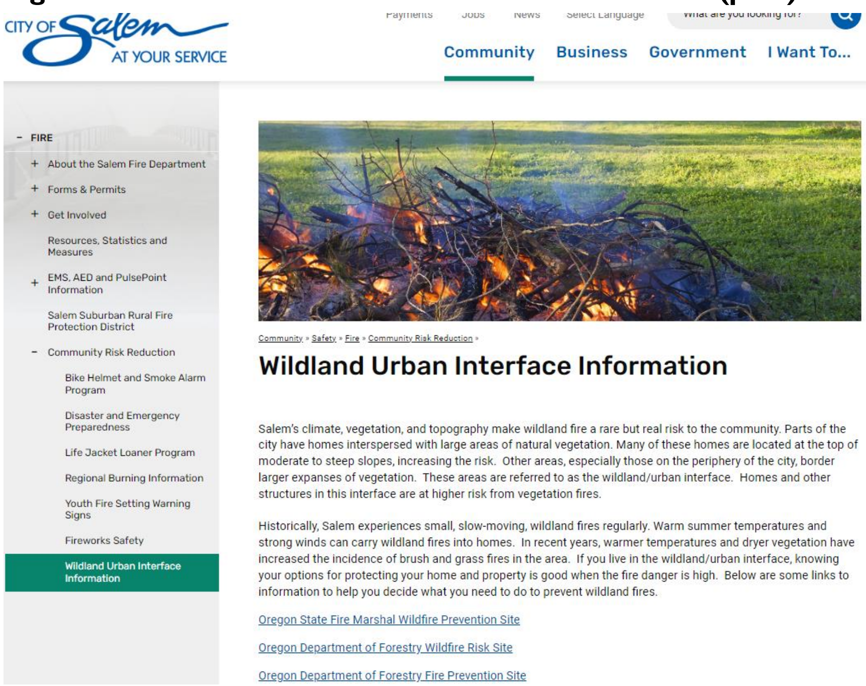
The City of Salem's Clean Streams, Clear Choices initiative was developed to educate the community on impactful choices you can make to help keep pollution out of the stormwater runoff and local streams. Stormwater runoff does not go to a treatment plant, but instead goes directly into the streams. Because of this, Salem's urban stormwater runoff carries pollutants to the stream that can affect the water quality and aquatic life within local streams. Salem provides information about what the community can do to help keep their streams clean and to reduce pollution.

Wildfire

City of Salem, Wildland Urban Interface Information

Salem's climate, vegetation, and topography make wildland fire a rare but real risk to the community. Parts of Salem have homes interspersed with large areas of natural vegetation. Many of these homes are located at the top of moderate to steep slopes, increasing the risk. Other areas, especially those on the periphery of the city, border larger expanses of vegetation. Salem's Wildland Urban Interface Information provides the community with risk reduction resources including links to Oregon State Fire Marshal's Wildfire Prevention website and Oregon Department of Forestry's Wildfire Risk and Fire Prevention webpages. Salem's webpage is shown, in part, in Figure 62 below.

Figure 62 Salem Wildland Urban Interface Website (part)



Source: City of Salem

Salem Community Development

All development within the City of Salem must comply with the fire protection construction standards in the Uniform Building Code (UBC) and the City of Salem Unified Development Code, as well as additional standards set forth by the applicable rural fire protection districts. Salem also provides a community risk reduction resource page that includes information on fireworks safety and understanding the earning signs of youth fire setting behavior.

Mutual Aid Agreements

Mutual Aid Agreements exist among the various fire authorities for support and help as needed. Each authority has its regulations and limitations, which dictates its fire management activity. In and around Salem, there is the Salem Fire Department and the Salem Suburban Rural Fire Protection District (SSRFPD). Salem also has Mutual Aid Agreements with Polk County Fire Defense Board and Marion County Fire Defense Board.

Salem Fire Department and the SSRFPD information can be found here: https://www.cityofsalem.net/community/safety/fire and https://www.cityofsalem.net/community/safety/fire/salem-suburban-rural-fire-protection-district

Winter Storm

Salem Snow and Ice Control Plan

The Salem *Snow and Ice Control Plan* (2019) establishes policies, procedures, and training to meet specified levels of service and is routinely reviewed. Collaboration occurs with City of Salem and all adjoining transit, school transportation, municipal, county, federal, and state agencies, to compare and share new technologies, practices, materials, and methods, and to confirm shared and exchanged response routes along the periphery of each jurisdiction. Assigned snow and ice response routes will be prioritized by volume of traffic, grade of roadway, terrain, elevation, neighborhood inter-connecting traffic patterns, and locations of government and emergency facilities, with flexibility to adapt to heavy commute patterns.

SECTION 4: PLAN IMPLEMENTATION AND MAINTENANCE

The Plan Implementation and Maintenance section details the formal process that will ensure that the City of Salem's NHMP remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the plan semi-annually, as well as producing an updated plan every five years. This section describes how the city will integrate public participation throughout the plan maintenance process. Finally, this section includes an explanation of how the City of Salem government intends to incorporate the mitigation strategies outlined in the plan into existing planning mechanisms.

Implementing the Plan

The success of the City of Salem NHMP depends on how well the outlined action items are implemented. In an effort to ensure that the activities identified are implemented, the following steps will be taken: 1) the plan will be formally adopted, 2) a convener shall be designated, 3) a coordinating body will be assigned, 4) the identified activities will be prioritized and evaluated, and 5) the plan will be implemented through existing plans, programs, and policies.

Plan Adoption

The *2023 City of Salem NHMP* was developed and will be implemented through a collaborative process. After the plan is locally reviewed and deemed complete, the DLCD Project Manager, with approval from the Plan Convener, will submit the plan to the Mitigation Planner at the Oregon Department of Emergency Management (OEM). OEM reviews the plan and returns it for edits. The DLCD Project Manager will make those edits or consult with the Plan Convener and Steering Committee as needed, and then re-submits the plan to FEMA-Region X for review. This review addresses the federal criteria outlined in the FEMA Interim Final Rule 44 CFR Part 201.

Upon pre-approval by FEMA, indicated by a letter provided from FEMA to City of Salem called the "Approvable Pending Adoption" (APA), the city will then adopt the NHMP via resolution. There are no other participating plan holder jurisdictions that will need to adopt the NHMP. Once the resolution is executed at the local level and documentation is provided to FEMA, the plan is formally acknowledged by FEMA, as evidenced by the issuance of the final FEMA plan approval letter. Once this letter is received, the DLCD Project Manager will finalize the plan draft with the final FEMA approval documents and the city will re-establish eligibility for the FEMA Hazard Mitigation Assistance funding, which includes the following programs: Building Resilient Infrastructure and Communities Program (BRIC), Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Fire Management Assistance Grant (FMAG) Program, Public Assistance (PA) Grant Program, Rehabilitation of High Hazard Potential Dam (RHHPD) Grant Program, and Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) Revolving Loan Fund.

The accomplishment of the *2023 Salem NHMP* goals and mitigation actions depends upon regular NHMP Coordinating Body participation and support from the city's leadership. Thorough familiarity with this NHMP will result in the efficient and effective implementation of mitigation actions, and the integration of the NHMP into plans, policies, and programs. This will result in a reduction in the risk and the potential for loss from future natural hazard events.

A copy of the resolution of approval from Salem will be included in the *2023 Salem NHMP* once it is received. Copies of the FEMA APA and final approval letters will also be included in the *2023 Salem NHMP* in Word and PDF formats.

Convener and Coordinating Body

The Salem Emergency Manager, as Convener, will take responsibility for plan implementation. They will facilitate the Hazard Mitigation Coordinating Body meetings and assign tasks such as updating and presenting the plan to the rest of the members of the Coordinating Body. Plan implementation and evaluation will be a shared responsibility among the assigned Natural Hazard Coordinating Body Members. The Convener's responsibilities include:

- Coordinate Natural Hazard Coordinating Body meeting dates, times, locations, agendas, and member notification;
- Document the discussions and outcomes of committee meetings;
- Serve as a communication conduit between the Coordinating Body and the public/stakeholders;
- Identify emergency management-related funding sources for natural hazard mitigation projects; and
- Utilize the Risk Assessment to prioritize proposed natural hazard risk reduction projects.

Coordinating Body

The Salem Convener will form a Natural Hazard Coordinating Body for updating and implementing the NHMP. The Coordinating Body's responsibilities include:

- Attend plan maintenance and update meetings (or designate a representative to serve in your place);
- Serve as the local evaluation committee for funding programs such as the Building Resilient Infrastructure and Communities, Hazard Mitigation Grant, and Flood Mitigation Assistance program funds;
- Prioritize and recommend funding for natural hazard risk reduction projects;
- Evaluate and update the NHMP in accordance with the prescribed maintenance schedule;
- Develop and coordinate ad hoc and standing subcommittees as needed; and
- Coordinate public involvement activities.

Members

The following authorities, agencies, or organizations were represented and served on the Steering Committee during the development of the *2023 Salem NHMP* (for a list of individuals, see Planning and Public Process (Volume II: Appendix B)):

City of Salem

- Community and Urban Development
- Community Services (Parks)
- Emergency Management
- Enterprise Services
- Human Resources (Risk Management)
- Manager's Office
- Public Works
- Salem Fire
- Salem Police

Partner Agencies and Organizations

- Chemawa Indian School
- Chemeketa Community College
- Cherriots Transportation
- City of Turner
- Corban University
- Mano A Mano
- Marion County Emergency Management
- Marion Polk Food Share
- Mid-Willamette Valley Community Action, The ARCHES Project
- Mid-Willamette Valley Council of Government
- North Santiam Watershed Council
- Northwest Natural Gas
- Oregon Joint Operation Center
- Polk County Emergency Management
- Portland General Electric
- Red Cross
- Salem Electric
- Salem Health
- Salem Keizer School District
- Salem Leadership Foundation, Church of the Park
- ServPro/Salem Fire Foundation
- Willamette University
- Willamette Valley Communications Center (WVCC)

To make the coordination and review of the Salem NHMP as broad and useful as possible, the Coordinating Body will engage other stakeholders and relevant hazard mitigation organizations and agencies to implement the identified action items. Specific organizations have been identified as internal or external partners on Appendix A's individual action item forms.

Implementation through Existing Programs

The *2023 Salem NHMP* includes a range of action items that, when implemented, will reduce loss from hazard events in the city. Within the plan, FEMA requires identifying existing programs that might be used to implement these action items. Salem addresses statewide planning goals and legislative requirements through their comprehensive land use plan, capital improvement plans, mandated standards, and building codes. To the extent possible, Salem will work to incorporate the recommended mitigation action items into existing programs and procedures.

Many of the recommendations in the NHMP are consistent with the goals and objectives of the city's existing plans and policies. Where possible, Salem should implement the recommended actions in the NHMP through existing plans and policies. Plans and policies already in existence often have support from residents, businesses, and policymakers. Many land-use, comprehensive, and strategic plans get updated regularly and can adapt easily to changing conditions and needs. Implementing the action items in the NHMP through such plans and policies increases their likelihood of being supported and implemented.

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

- City Budget
- Community Wildfire Protection Plans
- Comprehensive Land Use Plans
- Economic Development Action Plans
- Emergency Operations Plans
- Zoning Ordinances and Building Codes

The specific plans that presently exist related to this NHMP and the FEMA requirements are listed in Table 28; these are the same plans listed in Community Profile (Volume II: Appendix C).

Table 28 City of Salem NHMP Supported Plans and Policies

Document	Year
Natural Hazards Mitigation Plan	2023, 2017 previous
Salem Emergency Management Plan	2023, 2018/2020 previous
Salem Fire Department Standards of Cover, 2018-2023	2018
Salem Area Comprehensive Plan	2022
Salem Revised Code	2017 recodified
Title V, Community Development Standards	
Title VI, Wastewater, Water and Stormwater	
Title VII, Permits, Streets and Public Ways	
Title X, Unified Development Code	
Salem Climate Action Plan	2021
2021 Inventory of Community Greenhouse Gas Emissions	2023, 2019 previous
Salem's Community Energy Strategy	2010
Salem Floodplain Management Plan	2018
Salem Transportation System Plan	2020
Salem Comprehensive Park System Plan	2013
Salem Historic Preservation Plan 2020-2030	2020

Document	Year
Salem Water Management and Conservation Plan	2019
Salem Water System Master Plan	1994
Stormwater Master Plan	2020
Stormwater Drainage Basin Plans	2019
Battle Creek Basin Plan	
Mill Creek Basin Plan	
Pringle Creek Basin Plan	
Sheltering Crisis Response	2022
Snow and Ice Control Plan	2019
Community Forestry Strategic Plan	2013
Salem Strategic Plan 2021-2026	2021, 2017 previous
Salem Municipal Airport Master Plan	2012
Franzen Dam Emergency Operations Plan	2019
Croft Reservoir Dam Emergency Operation Plan	2018
North Santiam Watershed Council North Santiam Watershed Drought Contingency Plan	2018, update in process
Marion County Community Wildfire Protection Plan	2017

Source: *2023 Salem NHMP* Steering Committee

Plan Maintenance

Plan maintenance is a critical part of the NHMP. Proper maintenance of the plan ensures that this plan will maximize the city's efforts to reduce the risks posed by natural hazards. OPDR developed this section for the *2017 City of Salem NHMP* and which was retained for the 2023 NHMP. The section includes a process to ensure that a regular review and update of the plan occurs. The coordinating body and local staff are responsible for implementing this process and maintaining and updating the plan through a series of meetings outlined in the maintenance schedule below.

Meetings

The Coordinating Body will meet on a **semi-annual basis** (twice per year) to complete the following tasks. During the first meeting, the Coordinating Body will:

- 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; and
- Prioritize potential mitigation projects using the method described below.

During the second meeting, the Coordinating Body will:

- Review existing and new risk assessment data;
- Discuss methods for continued public involvement; and

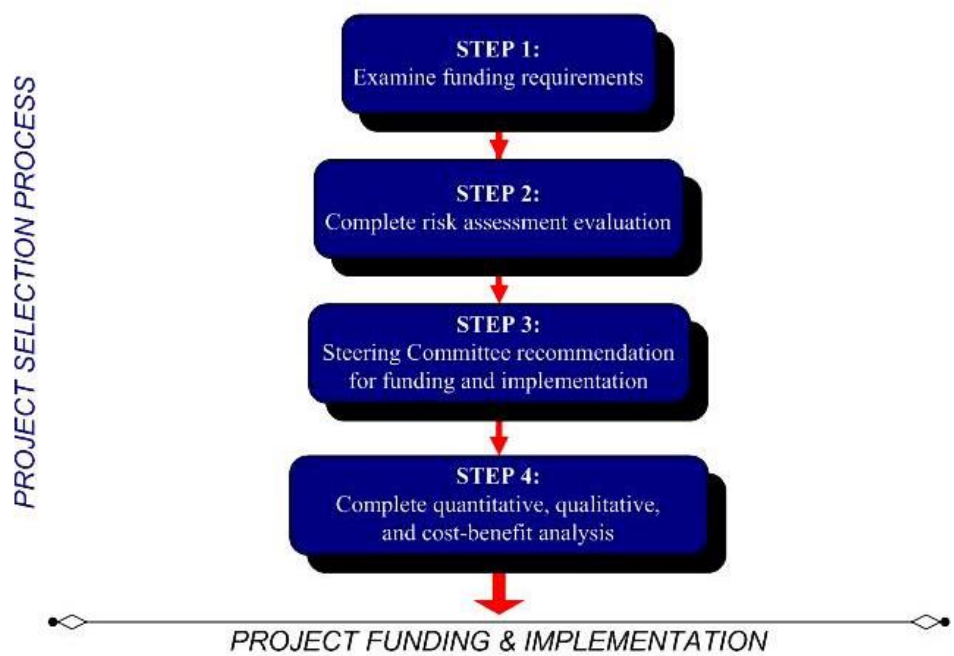
- Document successes and lessons learned during the year.

The Convener will be responsible for documenting the outcome of the semi-annual meetings in Appendix B. The process the Coordinating Body will use to prioritize mitigation projects is detailed in the section below. The plan's format allows the city 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.

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 various 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 63illustrates the project development and prioritization process.

Figure 63 Action Item and Project Review Process



Source: Oregon Partnership for Disaster Resilience, 2008.

Step 1: Examine funding requirements

The first step in prioritizing the plan's action items is determining which funding sources are available for application. Several funding sources may be appropriate for the city's proposed mitigation projects. Examples of mitigation funding sources include but are not limited to FEMA Hazard Mitigation Assistance funding, which includes the following three programs: Building Resilient Infrastructure and Communities Program, Hazard Mitigation Grant Program, and Flood Mitigation Assistance. Other funding may include National Fire Plan

(NFP), Community Development Block Grants (CDBG), local general funds, and private foundations, among others. Please see Appendix E, Grant Programs, for a more comprehensive list of potential grant programs.

Because grant programs open and close on differing schedules, the Coordinating Body will examine upcoming funding streams' requirements to determine eligible mitigation activities. The Coordinating Body may consult with the funding entity, Oregon Department of Emergency Management, or other appropriate state or regional organizations about project eligibility requirements. This examination of funding sources and requirements will happen 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 the plan's risk assessment supports the implementation of eligible mitigation activities. This determination will be based on the location of the potential activities, their proximity to known hazard areas, and whether community assets are at risk. The Coordinating Body will additionally consider whether the selected actions mitigate hazards that are likely to occur in the future or are likely to result in severe/catastrophic damages.

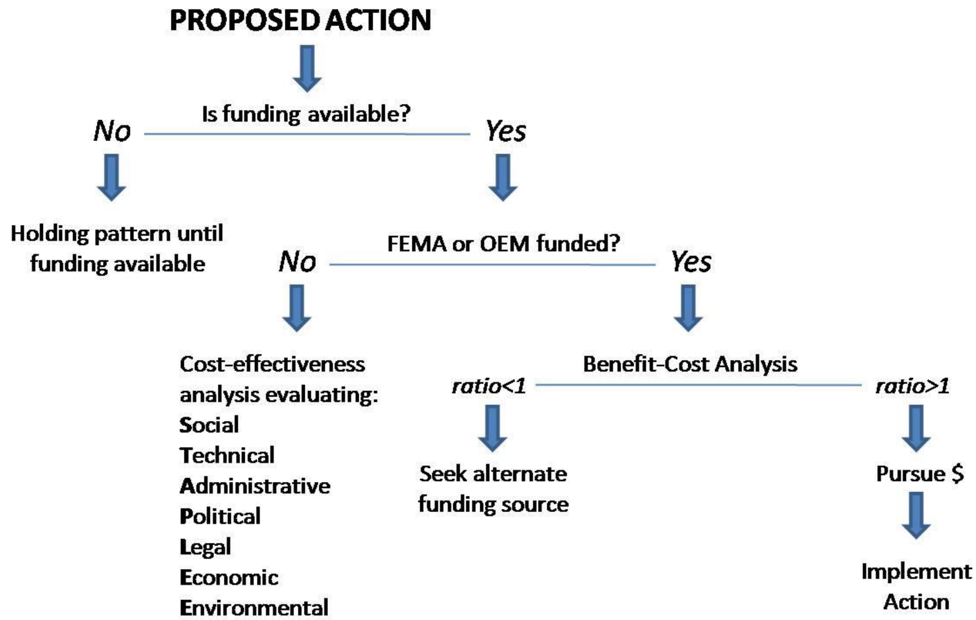
Step 3: Coordinating Body Recommendation

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 on the action item form will be responsible for taking further action and, if applicable, documenting success upon project completion. The Coordinating Body will convene a meeting to review grant application issues and share knowledge and resources. This process will afford greater coordination and less competition for limited funds.

Step 4: Quantitative and qualitative assessment and economic analysis

The fourth step is identifying 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 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 64shows the decision criteria for selecting the appropriate method of analysis.

Figure 64 Benefit Cost Decision Criteria



Source: Institute for Policy Research and Engagement in the School of Planning, Public Policy and Management. (2010.) Oregon Partnership for Disaster Resilience. University of Oregon.

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 to be eligible for FEMA grant funding.

A qualitative assessment will be completed for non-federally funded or nonstructural projects to determine the 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. OPDR at the University of Oregon's Institute for Policy Research and Engagement in the School of Planning, Public Policy and Management has tailored the STAPLE/E technique for use in natural hazard action item prioritization. See Appendix D, Economic Analysis, for a description of the STAPLE/E evaluation method.

Continued Public Involvement and Participation

The participating jurisdictions are dedicated to involving the public directly in continually reshaping and updating the Salem NHMP. Although members of the Coordinating Body represent the public, the public will also have the opportunity to continue to provide feedback about the plan.

To ensure that these opportunities will continue, the city will:

- Post copies of the *2023 Salem NHMP* on the city's website;

- Place articles in the local newspaper directing the public where to view and provide feedback;
- Use existing newsletters such as schools and utility bills to inform the public where to view and provide feedback; and
- Use internet and social media tools.

The *2023 Salem NHMP* will be on the Salem website at: Emergencies & Disaster Preparedness | Salem, Oregon (cityofsalem.net). The NHMP may be archived and posted on the University of Oregon Libraries' Scholar's Bank Digital Archive at https://scholarsbank.uoregon.edu and on the Oregon Department of Land Conservation and Development's website at Department of Land Conservation and Development : Welcome Page : State of Oregon.

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. **With FEMA approval granted in 2023, the Salem NHMP would be due for an update in 2028**. The Convener, the City of Salem Emergency Manager, or their designated delegates, will organize the Coordinating Body to address plan update needs. The Coordinating Body will be responsible for updating any deficiencies found in the plan and for meeting the Disaster Mitigation Act of 2000's plan update requirements.

Table 29 is a 'toolkit' that can help the Convener in deciding which plan update activities can be discussed during regularly scheduled plan maintenance meetings and which activities require additional meeting time and the formation of sub-committees.

Table 29 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: Institute for Policy Research and Engagement in the School of Planning, Public Policy and Management. (2010), Oregon Partnership for Disaster Resilience. University of Oregon.

VOLUME II: APPENDICES

Appendix A: Action Items

This appendix contains the *2023 Salem Natural Hazard Mitigation Plan (NHMP)* mitigation strategy actions.

Appendix A-1 identifies the Priority Actions of the *2023 Salem NHMP* in Table A-1. The action item worksheets that follow Table A-1 present specific information for each priority action item.

Appendix A-2 identifies the Action Item Pool of additional action items in Table A-2. The associated action item worksheets follow Table A-2 with specific information related to each action item.

Appendix A-1: Priority Action Items

Table A-1 lists priority actions for the *2023 Salem NHMP*. The action item worksheets that follow Table A-1 present specific information for each action item.

Table A-1 High Priority NHMP Actions

Mitigation Action ID	Mitigation Action Title
Priority Actions	
Multi-Hazard	
MH #1	Identify, map, and periodically revisit network of critical routes. Identify street segments prone to flooding. Consider bridge age and condition within critical routes.
MH #6	Identify and plan to strengthen or replace unsafe public structures, infrastructure, and utilities (especially facilities critical to disaster and post-disaster planning/response).
MH #7	Maintain, improve, and test Salem's alert and warning systems to notify residents of incidents involving natural hazards and hazardous materials. Continue to educate the community about the systems value.
MH #10	Conduct assessments of the short- and long-term needs for infrastructure to improve access to critical facilities and support systems for functional needs populations in the event of a hazard.
MH #11	Plan for a network of neighborhood resilience hubs, indoor gathering places that can function as community centers, cooling centers, food distribution, places to access electricity during power outages, evacuation sites, day cares, and community learning centers
MH #12	Engage faith communities, social service agencies, nonprofits and neighborhood associations in building community resilience.
MH #13	Analyze how historical inequities may make certain populations more vulnerable to inadequate transportation options in the event of an emergency. Incorporate best practices into emergency plans to ensure all users have adequate transportation options in emergency contexts.

Source: Salem NHMP Steering Committee (2023)

Priority Action Item Worksheets

Action Item: Multi-Hazard #1	**Alignment with Plan Goals:**
Identify, map, and periodically revisit network of critical routes. Identify street segments prone to flooding. Consider bridge age and condition within critical routes.	Goals 2, 3 and 5

Alignment with Existing Plans/Policies:		
Transportation System Plan (2020)		
Rationale for Proposed Action Item:		
Salem's arterial street system connects people to critical facilities as well as providing emergency response and evacuation routes in the event of natural hazards. Planning for and maintaining a robust network of critical routes supports the health and safety of the community. Identification of transportation improvement projects for both existing and new facilities should take into consideration the function of the street as a critical route for emergency management purposes. Data available to support this analysis includes identification of street segments that are prone to flooding and information gained through bridge inspection reports. Future transportation projects should consider opportunities to reduce the potential for critical routes to be blocked during major floods or other hazards.		
Ideas for Implementation:		
Work with City GIS experts to develop and maintain up to date maps and data related to critical routes network. Share with appropriate departments and agencies.		
Coordinating Organization:	Public Works	
Internal Partners:	**External Partners:**	
Emergency Management	Cherriots, Neighborhood Associations, civic leadership groups	
Potential Funding Sources:	**Estimated cost:**	**Timeline:**
BRIC, TSGP, IBSGP, PROTECT, Salem General Fund, Salem Gas Tax, Salem General Obligation (GO) Bond, Salem Impact Fees, Salem Stormwater Utility Fees, Salem Transportation System Development Charges (SDCs)	TBD	☐ Ongoing ☒ Short Term (0-2 years) ☐ Mid-Term (3-5 years) ☐ Long-Term (5+ years)
Form Submitted by:	Salem Natural Hazards Mitigation Committee (2023)	
Action Item Status:	New	

<table>
<tr><th colspan="4">Action Item: Multi-Hazard #6</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="4">Identify and plan to strengthen or replace unsafe public structures, infrastructure, and utilities (especially facilities critical to disaster and post-disaster planning/response).</td><td colspan="2">Goals 1, 2, 3 and 5</td></tr>
<tr><td colspan="6">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="6">Capital Improvement Plan (CIP)</td></tr>
<tr><td colspan="6">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="6">• The Disaster Mitigation Act of 2000 requires communities to assess their vulnerability to natural hazards, particularly by identifying the types and number of buildings, infrastructure, and critical facilities that could be affected.
• It is important that critical facilities function during and after disasters. Strengthening all essential facilities will improve recovery capacity and reduce risk and loss of life.
• Retrofitting of vital infrastructure, such as schools and community buildings, provides important improvements that reduce hazard exposure and the cost and time associated with recovery.</td></tr>
<tr><td colspan="6">Ideas for Implementation:</td></tr>
<tr><td colspan="6">• Develop formal agreements with internal and external partners who could assist the partners in collaborating and sharing the responsibility of natural hazard mitigation. Such actions to form collaborative partnerships and commitments to mitigation can assist Salem in reducing its risk to the natural hazards addressed by the Natural Hazards Mitigation Plan.
• Conduct structural and non-structural retrofits of critical facilities, infrastructure, and utilities to reduce the impacts of a natural hazard.
• Conduct a cost-benefit analysis to assess whether the cost of mitigation improvements to critical facilities balance with the benefits to be gained.
• Create proposals to reinforce buildings, infrastructure, and utilities so they can withstand an earthquake and other natural hazards and thereby reduce vulnerability risks; ORS 455.447 regulates vulnerable building retrofits.</td></tr>
<tr><td colspan="2">Coordinating Organization:</td><td colspan="4">Public Works</td></tr>
<tr><td colspan="3">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="3">Fire Department, Police Department, Community Development, Urban Development, Administrative Services</td><td colspan="3">FEMA, ODOT</td></tr>
<tr><td colspan="3">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="3">FMA, HMGP, BRIC, SRGP, TSGP, IBSGP, PROTECT, Oregon SRGP, Salem Gas Tax, Salem SDCs, Salem Impact Fees, Salem Stormwater Utility Fees, Salem GO Bond</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="5">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="5">Ongoing, revised from 2017 version of the NHMP as an ongoing action</td></tr>
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<tr><td colspan="3">Action Item: Multi-Hazard #7</td><td colspan="2">Alignment with Plan Goals:</td></tr>
<tr><td colspan="3">Maintain, improve, and test Salem's alert and warning systems to notify residents of incidents involving natural hazards and hazardous materials. Continue to educate the community about the systems value.</td><td colspan="2">Goals 3, 4, 5 and 7</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">• Alert and warning systems can provide a life-saving service to residents in the event of a natural or manmade disaster. Natural and manmade disasters can occur at any time, often unannounced, putting people at risk. Developing alert and warning systems can reduce the risk of exposure to natural hazard incidents and hazardous materials spills and help to save lives and property.
• Alert and warning systems have significant relevance to hazardous materials accidents. Hazardous materials are located near businesses and residences in Salem as well as along major transportation routes. Trucking routes along the I-5 corridor and Highway 22 may also contain hazardous materials because there are no restrictions on the type of cargo that travels over these routes which run through residential and commercial areas in the city. In addition, the heavily traveled railroad line near the Capital area has approximately 12,000 cars of hazardous materials running through the area each year. Accidents in businesses or on any of the above routes can have an adverse impact on the quality of life and economy of the city and the state; significant events have already occurred in Salem in 1976 and along the I-5 corridor. Alert and warning systems can help to prevent larger accidents from occurring and help to save lives and property.</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">• Continue to enforce the Salem Fire Prevention Code to regulate hazardous materials.
• Develop strategies in local building codes and zoning ordinances to reduce the impact of natural hazard and manmade hazard events on buildings and infrastructure.
• Continue to develop a reverse 9-11 system to alert nearby residents and businesses of natural hazard events or hazardous materials accidents.
• Develop improved maps to locate areas vulnerable to natural hazard events and hazardous materials.</td></tr>
<tr><td colspan="2">Coordinating Organization:</td><td colspan="3">Emergency Management</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Public Works, Police Department, GIS and Mapping Departments</td><td colspan="3">ODOT, FEMA, OSHA</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">Emergency Management Performance Grant (EMPG), Oregon SPIRE, Salem General Fund, Salem Impact Fees</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP</td></tr>
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<tr><td colspan="3">Action Item: Multi-Hazard #10</td><td colspan="2">Alignment with Plan Goals:</td></tr>
<tr><td colspan="3">Conduct assessments of the short- and long-term needs for infrastructure to improve access to critical facilities and support systems for functional needs populations in the event of a hazard.</td><td colspan="2">Goals 1, 3, 4, 5 and 7</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5">Salem EOP, Marion County EOP, Marion County NHMP</td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">Marion County and City of Salem have been conducting an ongoing effort to address functional needs populations. This action acknowledges the success of that work and acknowledges that additional effort is needed. Functional needs populations are an identified priority for the city and county. Salem will participate with the county’s corresponding NHMP action (Marion County 2022 NHMP Priority Action #2017 MH-04).</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">Interviews, focus groups and data analysis.</td></tr>
<tr><td colspan="2">Coordinating Organization:</td><td colspan="3">Emergency Management</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Salem Housing Authority, Community Development</td><td colspan="3">Marion County Emergency Management, Oregon DHS, Faith-Based Organizations, Non-Profits</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">BRIC, RCPGP, Community Facilities Program Disaster Repair Grants, Salem Impact Fees, Salem GO Bond, Americorps/ Resource Assistance for Rural Environments (RARE), Meyer Memorial Trust</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
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<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP</td></tr>
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<tr><td colspan="3">Action Item: Multi-Hazard #11</td><td>Alignment with Plan Goals:</td></tr>
<tr><td colspan="3">Plan for a network of neighborhood resilience hubs, indoor gathering places that can function as community centers, cooling centers, food distribution, places to access electricity during power outages, evacuation sites, day cares, and community learning centers</td><td>Goals 1, 4, 5 and 7</td></tr>
<tr><td colspan="4">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="4">Salem Comprehensive Plan, Salem Climate Action Plan</td></tr>
<tr><td colspan="4">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="4">Salem is growing in population and size. Planning and collaboration with agency/community partners can help to identify locations and potential operational needs for establishing facilities across the city where people can access vital services in times of emergency</td></tr>
<tr><td colspan="4">Ideas for Implementation:</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Coordinating Organization:</td><td colspan="3">Emergency Management</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="2">External Partners:</td></tr>
<tr><td colspan="2">Public Works, Community Services</td><td colspan="2">OPRD/State Fair, Marion & Polk Counties, Oregon Joint Operation Center and National Guard, Salem-Keizer School District, Neighborhood Associations, Faith-Based Organizations, Non-Profits</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td>Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">HMGP, BRIC, STORM, USDA Food and Nutrition Service Disaster Resources, EPA Wildfire Smoke Preparedness in Community Buildings Grant Program, Oregon Dept. Human Services Grants and Supports for Emergency Shelter, Oregon Dept. of Energy and House Bill 3630, Meyer Memorial Trust, Salem General Fund, Salem Building and Planning Fees, Salem GO Bond</td><td>TBD</td><td>☐ Ongoing
☐ Short Term (0-2 years)
☒ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
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<tr><td colspan="3">Action Item: Multi-Hazard #12</td><td colspan="2">Alignment with Plan Goals:</td></tr>
<tr><td colspan="3">Engage faith communities, social service agencies, nonprofits and neighborhood associations in building community resilience.</td><td colspan="2">Goals 4, 5 and 7</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5">Salem Comprehensive Plan, Salem Climate Action Plan</td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">Targeted communication/engagement can help ensure emergency preparedness/resiliency messaging is reaching the greatest amount of people (including underrepresented communities) most impacted by climate change and natural hazards. Can help Salem and partners collect critical feedback on concerns and needs in the community.</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
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<tr><td colspan="2">Coordinating Organization:</td><td colspan="3">Emergency Management</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Public Works, Community Development</td><td colspan="3">Neighborhood Associations, Faith-Based Organizations, Non-Profits</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">BRIC, CDBG, CDBG-MIT, HMA, HOME Investments Partnerships Program, Public Assistance Grant, Nonprofit Security Grant Program, RARE Program, Meyer Memorial Trust</td><td colspan="2">TBD</td><td>☐ Ongoing
☐ Short Term (0-2 years)
☒ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee (2023)</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">New</td></tr>
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Action Item: Multi-Hazard #13	Alignment with Plan Goals:
Analyze how historical inequities may make certain populations more vulnerable to inadequate transportation options in the event of an emergency. Incorporate best practices into emergency plans to ensure all users have adequate transportation options in emergency contexts.	Goals 4, 5 and 7

Alignment with Existing Plans/Policies:
Transportation System Plan (2020)
Rationale for Proposed Action Item:
Historical inequities directly impact transportation access for traditionally marginalized populations. This is a barrier for those populations in non-emergency situations, and surely would be in emergency situations as well. Salem is committed to removing that barrier in both emergency and non-emergency situations.
Ideas for Implementation:
Use tract-level census data to ascertain how and where transportation inequities exist in Salem. Develop a scoring system to identify which tracts are most vulnerable and elevate equity to a higher percentage when scoring potential transportation projects.

Coordinating Organization:	Public Works

Internal Partners:	External Partners:
	MWVCOG, ODOT, Marion County, Polk County

Potential Funding Sources:	Estimated cost:	Timeline:
BRIC, TSGP, IBSGP, PROTECT, EMPG, Salem General Fund, Salem Gas Tax, Salem GO Bond, Salem Impact Fees, Salem Stormwater Utility Fees, Salem SDCs	TBD	☐ Ongoing ☒ Short Term (0-2 years) ☐ Mid-Term (3-5 years) ☐ Long-Term (5+ years)

Form Submitted by:	Salem Natural Hazards Mitigation Committee (2023)
Action Item Status:	New

Appendix A-2: Action Item Pool

Table A-2 and the subsequent action item forms, are the complete list of non-priority actions for the *2023 Salem NHMP*.

Table A-2 Action Item Pool

Mitigation Action ID	Mitigation Action Title
Action Item Pool	
Multi-Hazard	
MH #2	Coordinate with the Capitol Planning Commission to integrate natural hazard mitigation into State and City respective capital improvements.
MH #3	Maintain an inventory of the number and type of critical facilities including government buildings, facilities, and utilities within the community that are at reasonable risk for each hazard type.
MH #4	Maintain public outreach materials for all natural hazard risks addressed in the Salem Natural Hazards Mitigation Plan. Materials should include mitigation actions residents and businesses can implement to reduce their risk to natural hazards, and where they can obtain more detailed natural hazard information.
MH #5	Ensure Unified Development Code (UDC) updates consider specific hazards and help to mitigate risk for future development in identified/mapped high hazard areas.
MH #8	Continue to follow and enforce regulations pertaining to hazard resistant construction-methods (wind, winter storm, landslide, etc.) where possible to reduce damage to utilities and critical facilities.
MH #9	Ensure City planning documents and regulations align with regard to natural hazards mitigation and the actions in the Natural Hazards Mitigation Plan, particularly State Planning Goal 7.
MH #14	Coordinate with the Council of Water Leaders to maintain strong partnerships in the watershed and allow rapid response to emerging issues and challenges.

Source: Salem NHMP Steering Committee (2023)

Table A-3 Action Item Pool (Continued)

Mitigation Action ID	Mitigation Action Title
Action Item Pool	
Multi-Hazard	
MH #15	Conduct strategic public outreach and update information on website to provide residents with information about proper tree care and planning criteria in order to reduce tree-related hazards and encourage planting of climate appropriate trees to maintain a healthy and diverse tree canopy in Salem.
Air Quality	
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.	
Drought	
DR #1	Update and continue to implement the North Santiam Watershed Drought Contingency Plan.
DR #2	Continue to promote water conservation to protect potable water supply and reduce impacts during drought through existing conservation programs and plans, such as the Clean Streams program, Drought Contingency Plan, Water Management and Conservation Plan, as well as any new initiatives.
DR #3	Expand the water conservation content on the website with an emphasis on providing more educational links and more information on water-efficient irrigation practices. Update water conservation brochures.
See multi-hazard actions for additional applicable mitigation strategies.	
Earthquake	
EQ #1	Identify, inventory, and mitigate (as prioritization and resources allow) critical facilities and utilities that require seismic retrofit (consider structural and non-structural retrofit options).
EQ #2	Stay informed of the school districts plans about the indentification and prioritization of school district facility retrofits and upgrades.
See multi-hazard actions for additional applicable mitigation strategies.	

Source: Salem NHMP Steering Committee (2023)

Table A-4 Action Item Pool (Continued)

Mitigation Action ID	Mitigation Action Title
Action	
Extreme Heat	
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.	
Flood	
FL #1	Update, maintain, and implement flood actions via a floodplain management plan in accordance with FEMA's Community Rating System guidelines.
FL #2	Improve and maintain the City of Salem's National Flood Insurance Program (NFIP) Community Rating System (CRS) rating in order to reduce flood risk and NFIP premiums.
See multi-hazard actions for additional applicable mitigation strategies.	
Landslide	
LS #1	Maintain landslide overlay maps using Light Detection and Ranging (LIDAR) data.
LS #2	Utilize the updated regional landslide risk maps (DOGAMI O-16-02) to identify hazard areas and collaborate with the Oregon Department of Geology and Mineral Industries to work on landslide risk reduction efforts; determine areas buildings, infrastructure, and utilities at risk to landslides and incorporate and utilize updated data when reviewing development applications.
See multi-hazard actions for additional applicable mitigation strategies.	
Volcano	
VO #1	Evaluate the impact of ash fall-out on HVAC systems in critical facilities. City could benefit from a quick sheet on this topic; guidance to contractors for maintenance.
See multi-hazard actions for additional applicable mitigation strategies.	
Water Quality/Emergency	
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.	
Windstorm	
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.	
Winter Storm	
No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.	
Wildfire	
WF #1	Conduct wildfire prevention outreach, as outlined in the Marion County and Polk County (West Salem) Community Wildfire Protection Plans (CWPPs), to residents near the wildland-urban interface.
See multi-hazard actions for additional applicable mitigation strategies.	

Source: Salem NHMP Steering Committee (2023)

Action Item Pool Worksheets

<table>
<tr><th colspan="3">Action Item: Multi-Hazard #2</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Coordinate with the Capitol Planning Commission to integrate natural hazard mitigation into State and City respective capital improvements.</td><td colspan="2">Goals 3 and 4</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5">Capital Improvement Plan (CIP)</td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">

The Capitol Planning Commission (SB 671, 2009 Session) is identified as the main body to implement the State of Oregon capital improvement projects within the greater Salem area. A similar responsibility rests with the Salem Public Works Department in the development and implementation of Salem's Capital Improvements Program (CIP).
It is important that natural hazard mitigation be integrated into both the State's and Salem's Capital Improvement Program so that critical public facilities, including government buildings, facilities, and utilities, are constructed to function during and after natural disasters. Local units of government want to ensure continuous service by strengthening essential facilities such as water and wastewater facilities. Ensuring continuous service will assist residents in recovering from a natural disaster as well as make the process easier.
The Disaster Mitigation Act of 2000 requires communities to maintain the Hazard Mitigation Plan by having local governments incorporate the requirements of the mitigation plan into other planning mechanisms [201.6(c)(4)(ii)]. Coordinating mitigation activities with other planning activities will help local governments incorporate mitigation into other plans and policies currently being developed. Coordination will also reduce duplication of planning efforts, strengthening the overall mitigation planning process.

</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">

Determine what roles the Capitol Planning Commission plays in mitigating natural hazards, especially for State of Oregon properties or others in Salem for which it has jurisdiction.
Review action items and discuss which ones can be integrated into Salem's Capital Improvement Programs.
Inventory critical facilities that may be potentially vulnerable to a natural disaster and present these to the Capitol Planning Commission for their review.
Include members of the Capitol Planning Commission in the NHMP Committee meetings
Realign or replace roads and utilities (e.g., water and wastewater facilities) when feasible during regularly scheduled replacement to reduce the impact of natural hazard events on new development.
Explore the possibility of undergrounding utilities that are vulnerable to severe weather.

</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="4">Community Development and Public Works Departments</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Natural Hazard Mitigation Committee</td><td colspan="3">FEMA, OEM, Capitol Planning Commission</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td>Estimated cost:</td><td colspan="2">Timeline:</td></tr>
<tr><td colspan="2">BRIC, Salem General Fund, Salem Impact Fees, Building and Planning Fees,</td><td>TBD</td><td colspan="2">☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP</td></tr>
</table>

<table>
<tr><th colspan="3">Action Item: Multi-Hazard #3</th><th>Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Maintain an inventory of the number and type of critical facilities including government buildings, facilities, and utilities within the community that are at reasonable risk for each hazard type.</td><td>Goals 2, 3 and 5</td></tr>
<tr><td colspan="4">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="4">Emergency Operations Plan, Comprehensive Plan, Capital Improvement Plan</td></tr>
<tr><td colspan="4">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="4">• Many older commercial buildings in Salem are vulnerable to damage in the event of a natural disaster. This could have significant impacts on Salem’s economy. Identifying and retrofitting buildings that are susceptible to a natural disaster will reduce the vulnerability of the buildings in the event of a natural disaster and improve the resiliency of Salem’s local economy.
• OEM’s checklist for local mitigation plans includes the need to estimate the type and number of structures within the community at risk for each hazard type, including residences, businesses, critical facilities (hospitals, fire stations, and storage sites for hazardous materials), and infrastructure (e.g., roads and utilities). There also needs to be a map of repetitive flood loss properties (extent of flooding, no evaluation of cost of property damage) and discussion of potential mitigation activities for these properties.
• The Disaster Mitigation Act of 2000 requires communities to identify actions and projects that reduce the effects of hazards on the community, particularly to buildings and infrastructure [201.6(c)(3)(ii)]. Inventorying important historic and cultural resources and identifying their vulnerability to natural hazards will help to develop mitigation actions that reduce Salem’s overall vulnerability to natural hazards.</td></tr>
<tr><td colspan="4">Ideas for Implementation:</td></tr>
<tr><td colspan="4">• Identify and construct projects within the Salem’s Capital Improvement Plan and other projects that address critical facilities’ vulnerability to natural hazards Conduct and/or update engineering studies and utility master plans to identify vulnerabilities to natural hazards and identify improvements needed to mitigate risk.
• Create an electronic data base which illustrates an inventory of the number and type of structures within the community that are at risk for each hazard type.
• Identify significant cultural and historic resources, whether on the national register or not, that are worthy of additional protection.</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="3">Public Works</td></tr>
<tr><td>Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td>Natural Hazards Mitigation Committee, GIS, IT</td><td colspan="3">FEMA</td></tr>
<tr><td>Potential Funding Sources:</td><td>Estimated cost:</td><td colspan="2">Timeline:</td></tr>
<tr><td>BRIC, Oregon SRGP, Salem General Fund, Salem Impact Fees, Building and Planning Fees, Salem Stormwater Utility Fees, Salem GO Bond</td><td>TBD</td><td colspan="2">☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="3">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="3">Retained, revised from 2017 version of the NHMP as an ongoing action</td></tr>
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<table>
<tr><th colspan="4">Action Item: Multi-Hazard #4</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="4">Maintain public outreach materials for all natural hazard risks addressed in the Salem Natural Hazards Mitigation Plan. Materials should include mitigation actions residents and businesses can implement to reduce their risk to natural hazards, and where they can obtain more detailed natural hazard information.</td><td colspan="2">Goals 1, 3, 4, 5 and 7</td></tr>
<tr><td colspan="6">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="6">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="6">Conducting public outreach campaigns raises awareness about natural hazards and helps illustrate what residents and businesses can do to reduce the impact of a natural disaster on their properties, thereby significantly reducing the impact of a natural disaster on Salem.
Several natural hazards, such as severe weather, earthquakes, and floods, have the potential for disrupting transportation services and isolating rural residents from basic services and needs. Salem residents need to be educated about the dangers that natural hazards pose and what actions they can take to mitigate the impact hazards on the community.
The Disaster Mitigation Act of 2000 requires communities to identify comprehensive actions and projects that reduce the effects of a hazard on the community [201.6(c)(3)(ii)].</td></tr>
<tr><td colspan="6">Ideas for Implementation:</td></tr>
<tr><td colspan="6">Conduct public outreach campaigns, such as articles in the newspaper or through brochures instructing residents and businesses about the risks natural hazards pose and mitigation actions they can implement.
Coordinate with other groups conducting other emergency management activities to assist in conducting public outreach campaigns, developing emergency kits, and educating residents and businesses about other mitigation activities
Develop handouts that inform residents and businesses about natural hazard risk, appropriate mitigation actions that can be implemented, and where citizens can obtain further information.
Create an online informational website where residents and businesses can be educated about appropriate mitigation actions residents and businesses can implement to reduce the impact of natural hazards
Work with local real estate trade associations to prepare informational handouts advising property owners of natural hazard risks in their area and measures they can implement to reduce their risk of exposure.</td></tr>
<tr><td colspan="2">Coordinating Organization:</td><td colspan="4">Emergency Management</td></tr>
<tr><td colspan="3">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="3">Community Development Department, Public Works</td><td colspan="3">FEMA, Oregon State Police, Oregon Department of Emergency Management, DOGAMI, DLCD</td></tr>
<tr><td colspan="3">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="3">BRIC, EMPG, Oregon SPIRE, Salem General Fund, Salem Impact Fees, Building and Planning Fees, Salem Stormwater Utility Fees, Salem GO Bond</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="5">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="5">Retained, revised from 2017 version of the NHMP as an ongoing action</td></tr>
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Action Item: Multi-Hazard #5			Alignment with Plan Goals:
Ensure Unified Development Code (UDC) updates consider specific and help to mitigate risk for future development in identified/mapped high hazard areas.			Goals 1, 2, 3, 5, 6 and 7
Alignment with Existing Plans/Policies:			
Rationale for Proposed Action Item:			
• Goal 7 of Oregon's Land Use Planning Goals requires that local governments "adopt or amend, as necessary, based on the evaluation of risk, plan policies and implementing measures... [that prohibit] the siting of essential facilities, major structures, hazardous facilities and special occupancy structures, as defined in the state building code (ORS 455.447(1) (a)(b)(c) and (e)), in identified hazard areas..." • The Disaster Mitigation Act of 2000 requires communities to identify actions and projects that reduce the effects of hazards on the community [201.6(c)(3)(ii)]. Adjusting the Salem code to move future development from identified/mapped hazards areas will reduce the vulnerability of new development to natural hazards.			
Ideas for Implementation:			
• Consider transferring development rights from high hazard areas to safer areas, especially in those areas where the risk to people and property cannot be mitigated. • Address high hazard areas and consider measures for mitigating the location of future development in these areas during the update of the Salem code.			
Coordinating Organization:	Salem Community Development and Public Works		
Internal Partners:		**External Partners:**	
Natural Hazards Mitigation Committee		DLCD, FEMA	
Potential Funding Sources:		**Estimated cost:**	**Timeline:**
BRIC, DLCD Technical Assistance Grant, DLCD Community Assistance Grant, Salem General Fund, Salem Impact Fees, Building and Planning Fees, Salem Stormwater Utility Fees, RARE Program		TBD	☒ Ongoing ☐ Short Term (0-2 years) ☐ Mid-Term (3-5 years) ☐ Long-Term (5+ years)
Form Submitted by:	Salem Natural Hazards Mitigation Committee		
Action Item Status:	Ongoing, revised from 2017 version of the NHMP		

<table>
<tr><th colspan="4">Action Item: Multi-Hazard #8</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="4">Continue to follow and enforce regulations pertaining to hazard resistant construction methods (wind, winter storm, landslide, etc.) where possible to reduce damage to utilities and critical facilities.</td><td colspan="2">Goals 1, 2, 3, 4 and 5</td></tr>
<tr><td colspan="6">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="6">Transportation Plan, Community Wildfire Protection Plans (Marion and Polk)</td></tr>
<tr><td colspan="6">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="6">Downed and damaged utility lines result in failures and block critical transportation routes. The loss of electric power and other utilities for a long period of time (more than 72 hours) can lead to failures of multiple critical systems including health care, water filtration, wastewater treatment, communications, transportation, and others. Impassable roadways from downed power lines also inhibit emergency response and restoration of critical services, such as drinking water and health care, and is particularly problematic if fuel for backup generators cannot be delivered. The hazards most likely to impair surface transportation and disrupt any utility services are severe winter storm (snow, ice, downed trees, utility pole, and wire failures) and earthquake (downed trees, utility pole and wire failures).</td></tr>
<tr><td colspan="6">Ideas for Implementation:</td></tr>
<tr><td colspan="6">Over the next five years:
a) Develop a list of key backbone transmission and distribution routes that serve critical customers and enable efficient restoration to the broader distribution system;
b) Develop a long-term plan to underground, relocate, or “harden” key electric and other utility distribution lines along critical corridors (including feasibility assessment and prioritization);
c) Seek funds and opportunities to relocate utility poles, lines, drainages, and other infrastructure, or harden existing facilities, where feasible and appropriate, to reduce blockage of roadways, disrupted service, and to reduce risk of damage from natural disasters; and
d) Continue to enhance wind and winter storm resistant construction methods where possible to reduce damage to utilities and critical facilities.</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="5">Public Works</td></tr>
<tr><td colspan="3">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="3">Community Development, Emergency Management, GIS</td><td colspan="3">Public Utility Commission, Utility and communication companies</td></tr>
<tr><td colspan="3">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="3">HMGP, BRIC, SRGP, TSGP, IBSGP, PROTECT, Electric Utilities, Oregon SRGP, Salem Gas Tax, Salem SDCs, Salem Impact Fees, Building and Planning Fees, Salem Stormwater Utility Fees</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td colspan="2">Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee (2017)</td></tr>
<tr><td colspan="2">Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP as an ongoing action</td></tr>
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Action Item: Multi-Hazard #9	Alignment with Plan Goals:
Ensure City planning documents and regulations align with regard to natural hazards mitigation and the actions in the Natural Hazards Mitigation Plan, particularly State Planning Goal 7.	Goals 3 and 4

Alignment with Existing Plans/Policies:
Action proposes integration with relevant existing plans and policies, including Salem's comprehensive plan.
Rationale for Proposed Action Item:
The federal Disaster Mitigation Act of 2000 requires communities to describe a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, when appropriate. Every five years, natural hazard mitigation plans must be updated and resubmitted for approval to continue to be eligible for mitigation project grant funding. The updated plan must explain how the local government incorporated the mitigation plan into other planning mechanisms, when appropriate, as a demonstration of progress in local mitigation efforts. This action item serves as a reminder to the Natural Hazards Mitigation Plan committee that efforts must be made to integrate the requirements of the mitigation plan into other planning mechanisms.
Ideas for Implementation:
Local government functions provide a myriad of methods in which to implement actions identified in the mitigation strategy. Among them is the comprehensive plan. Others include, but are not limited to, the following: sustainability programs, capital improvement plans, redevelopment plans, post-disaster redevelopment or recovery plans, regional development plans, flood mitigation plans, college campus plans, etc. (see FEMA's Local Mitigation Planning Handbook, March 2013). Conduct an 'audit' of the Salem Comprehensive Plan (specifically, Goal 7). Determine whether information needs to be (or can be) updated by content within the natural hazard mitigation plan or otherwise. Develop a strategy and timeline for updating Goal 7 content. Ideally, integration should happen as a dedicated component of future comprehensive plan or natural hazards mitigation plan updates. Inventory and review other local plans to identify gaps, weaknesses, or opportunities for enhancing plan integration.

Coordinating Organization:	Community Development

Internal Partners:	**External Partners:**
Emergency Management, Public Works, City Administration	FEMA, American Planning Association, DLCD, OEM

Potential Funding Sources:	**Estimated cost:**	**Timeline:**
BRIC, DLCD Technical Assistance Grants, DLCD Community Assistance Grant, Salem General Fund, Salem Impact Fees, Building and Planning Fees, Salem Stormwater Utility Fees, RARE Program	TBD	☒ Ongoing ☐ Short Term (0-2 years) ☐ Mid-Term (3-5 years) ☐ Long-Term (5+ years)

Form Submitted by:	Salem Natural Hazards Mitigation Committee
Action Item Status:	Ongoing, revised from 2017 version of the NHMP as an ongoing action

<table>
<tr><th colspan="3">Action Item: Multi-Hazard #14</th><th>Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Coordinate with the Council of Water Leaders to maintain strong partnerships in the watershed and allow rapid response to emerging issues and challenges.</td><td>Goals 3 and 4</td></tr>
<tr><td colspan="4">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="4">North Santiam Watershed Drought Contingency Plan, Salem Climate Action Plan, Salem Clean Streams program</td></tr>
<tr><td colspan="4">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="4">The Council of Water Leaders, created in 2022, is a forum that creates a pathway to improve water management in the North Santiam Basin by providing decision-makers with the latest information about water issues and increasing coordination among organizations</td></tr>
<tr><td colspan="4">Ideas for Implementation:</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Coordinating Organization:</td><td colspan="3">Public Works</td></tr>
<tr><td>Internal Partners:</td><td></td><td colspan="2">External Partners:</td></tr>
<tr><td colspan="2">Emergency Management, Community Development</td><td colspan="2">Santiam Water Control District, municipal water providers, Tribes, city and county governments, nonprofits, businesses, interest groups, irrigators, state and federal agencies, and elected officials.</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td>Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">BRIC, CWSRF, WaterSMART, Emergency Watershed Protection (EWP), EPA Emergency Response for Drinking Water and Wastewater Utilities, EFA Funding for Water and Wastewater Utilities in National Disasters, Partners for Fish and Wildlife, Salem General Fund, Salem Impact Fees, Salem Stormwater Utility Fees</td><td></td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="3">Salem Natural Hazards Mitigation Committee (2023)</td></tr>
<tr><td>Action Item Status:</td><td colspan="3">New</td></tr>
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<table>
<tr><th colspan="3">Action Item: Multi-Hazard #15</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Conduct strategic public outreach and update information on website to provide residents with information about proper tree care and planning criteria in order to reduce tree-related hazards and encourage planning of climate appropriate trees to maintain a healthy and diverse tree canopy in Salem.</td><td colspan="2">Goals 1, 3, 4, 5 and 7</td></tr>
<tr><th colspan="5">Alignment with Existing Plans/Policies:</th></tr>
<tr><td colspan="5"></td></tr>
<tr><th colspan="5">Rationale for Proposed Action Item:</th></tr>
<tr><td colspan="5">While trees can be hazards during windstorms or winter storms, this is usually due to the wrong tree being planted in the wrong place or improper care of the tree. Trees are important for combating heat islands, they moderate air temperatures, clean our air and water, slow stormwater, and stabilize soils, just to name a few benefits. The goal should not be to warn people of the hazards of trees during storms, but rather to teach people how to maintain healthy and resilient trees.</td></tr>
<tr><th colspan="5">Ideas for Implementation:</th></tr>
<tr><td colspan="5">Work with the community and Salem Public Works Department to identify areas that are prone to damage from nearby trees and perform the necessary maintenance or removal of those trees.</td></tr>
<tr><th colspan="2">Coordinating Organization:</th><td colspan="3">Public Works</td></tr>
<tr><th colspan="2">Internal Partners:</th><th colspan="3">External Partners:</th></tr>
<tr><td colspan="2">Fire Department</td><td colspan="3">ODOT, Portland General Electric, Salem Electric</td></tr>
<tr><th colspan="2">Potential Funding Sources:</th><th colspan="2">Estimated cost:</th><th>Timeline:</th></tr>
<tr><td colspan="2">BRIC, Oregon Landscape Resiliency Program, Utilities, Salem General Fund, Salem Gas Tax, Salem SDCs, Salem Impact Fees, Building and Planning Fees, Salem Stormwater Utility Fees, Salem SDCs, RARE Program</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><th>Form Submitted by:</th><td colspan="4">Salem Natural Hazards Mitigation Committee 2023</td></tr>
<tr><th>Action Item Status:</th><td colspan="4">Ongoing Windstorm and Winter Storm action, revised to a Multi-Hazard action from 2017 version of the NHMP</td></tr>
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<table>
<tr><th colspan="3">Action Item: Drought #1</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Update and continue to implement the North Santiam Drought Watershed Contingency Plan</td><td colspan="2">Goals 1, 3, 4 and 6</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5">North Santiam Watershed Drought Contingency Plan, Salem Water Master Plan, Comprehensive Plan, Salem Water Management and Conservation Plan</td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">Water availability is an increasing concern in Salem and Marion County. The ongoing water contingency planning effort is an innovative and successful collaboration between numerous local and regional partners. The effort is already resulting in significant mitigation benefits across Marion County.</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">Complete updating existing plan, adopt and begin to implement the updated plan.</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="4">Public Works</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">City Departments</td><td colspan="3">Marion County (Emergency Management), Santiam Water Control District, City of Stayton, Linn Soil & Water Conservation District, Marion Soil & Water Conservation District, Norpac Foods, Inc., North Santiam Watershed Council, Oregon Department of Agriculture, Oregon Department of Environmental Quality, Oregon Department of Forestry</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td>Estimated cost:</td><td colspan="2">Timeline:</td></tr>
<tr><td colspan="2">WaterSMART, BRIC, CWSRF, Emergency Watershed Protection (EWP), EPA Emergency Response for Drinking Water and Wastewater Utilities, EPA Funding for Water and Wastewater Utilities in National Disasters, Partners for Fish and Wildlife, Salem General Fund, Salem Impact Fees, Salem Stormwater Utility Fees, Salem GO Bond</td><td>TBD</td><td colspan="2">☐ Ongoing
☒ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP</td></tr>
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<table>
<tr><td colspan="3">Action Item: Drought #2</td><td colspan="2">Alignment with Plan Goals:</td></tr>
<tr><td colspan="3">Continue to promote water conservation to protect potable water supply and reduce impacts during drought through existing conservation programs and plans, such as the Clean Streams program, Drought Contingency Plan, Water Management and Conservation Plan, as well as any new initiatives.</td><td colspan="2">Goals 1, 3, 4, 5 and 7</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5">Salem Comprehensive Plan, Salem Climate Action Plan, North Santiam Watershed Drought Contingency Plan, Salem Water Management and Conservation Plan, Clean Streams program, Capital Improvement Plan</td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">Amid ever-increasing demands on water sources and changing weather patterns due to climate change, it is important to promote water conservation and plan and prepare for times of water scarcity. The City of Salem’s primary drinking water source is located on the North Santiam River outside of Stayton, and water is distributed to the city via a network of pipes. As the population of Salem continues to grow, so does the importance of water conservation to ensure that supply can continue to meet demand.</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">Continue working on and expanding efforts related the Drought Contingency Plan, Water Management and Conservation Plan, and the Stormwater Quality group’s Clean Streams Program, ensuring that plans are implemented, and information is shared with stakeholders and the public. Collaborate with partners like Glenn Gibson Watershed Council, North Santiam Watershed Council, Marion Soil and Water Conservation District, Polk SWCD, and others to share information and develop programs to promote water conservation. Continue to participate in groups like the Council of Water Leaders and Partners of the North Santiam to identify opportunities to protect and conserve water at the source.
Implement projects within the CIP designed to address water conservation and drought.
Conduct and/or update engineering studies and utility master plans to identify projects to address water conservation and address drought risk.</td></tr>
<tr><td colspan="2">Coordinating Organization:</td><td colspan="3">Public Works</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Emergency Management, City Departments</td><td colspan="3">North Santiam Watershed Council, Glenn Gibson Watershed Council, Marion and Polk Soil and Water Conservation Districts</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">WaterSMART, BRIC, CWSRF, Emergency Watershed Protection, EPA Emergency Response for Drinking Water and Wastewater Utilities, EPA Funding for Water and Wastewater Utilities in National Disasters, Partners for Fish and Wildlife, Salem General Fund, Salem Impact Fees, Salem Stormwater Utility Fees</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee (2023)</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">New</td></tr>
</table>

<table>
<tr><th colspan="4">Action Item: Drought #3</th><th>Alignment with Plan Goals:</th></tr>
<tr><td colspan="4">Expand the water conservation content on the website with an emphasis on providing more educational links and more information on water-efficient irrigation practices. Update water conservation brochures</td><td>Goals 4 and 5</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5">Salem Water Management and Conservation Plan</td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">Encouraging residents to conserve water and reducing use of water for landscape irrigation will help reduce overall water use and hopefully keep more water in reserve for essential uses during emergencies. One of the primary venues we have for helping residents conserve water is through public education campaigns, including having useful/relevant information on our website.</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">Review and update/refine website content related to water use, conservation strategies, and water source. Include educational links to good relevant outside sources of information. Provide ideas for actions that residents can take to help conserve water, highlighting any incentive or assistance programs available locally through organizations like Marion SWCD, Polk SWCD, NRCS, Watershed Councils, etc. Update water conservation brochures to make sure that info is highly relevant and easily digestible/implementable.</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="4">Public Works</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Community Development</td><td colspan="3"></td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td>Estimated cost:</td><td colspan="2">Timeline:</td></tr>
<tr><td colspan="2">WaterSMART, BRIC, CWSRF, Emergency Watershed Protection, EPA Emergency Response for Drinking Water and Wastewater Utilities, EPA Funding for Water and Wastewater Utilities in National Disasters, Partners for Fish and Wildlife, Salem General Fund, Salem Impact Fees, Salem Stormwater Utility Fees</td><td>TBD</td><td colspan="2">☐ Ongoing
☒ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
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<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee (2023)</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">New</td></tr>
</table>

<table>
<tr><th colspan="3">Action Item: Earthquake #1</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Identify, inventory, and mitigate (as prioritization and resources allow) critical facilities and utilities that require seismic retrofit (consider structural and non-structural retrofit options).</td><td colspan="2">Goals 2, 3 and 5</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5">Capital Improvement Plan</td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">
• The Salem NHMP Steering Committee noted that certain critical facilities have a high vulnerability for seismic events. Seismically retrofitting these facilities will significantly reduce their vulnerability in the event of an earthquake.
• Oregon Senate Bill 3 (2005) enabled the state to develop a grant program to seismically rehabilitate critical public facilities. Conducting an inventory of critical facilities early will assist communities in obtaining funding.
• The Disaster Mitigation Act of 2000 requires communities to identify comprehensive actions that protect new and existing buildings [201.6(c)(3)(ii)]. Seismically retrofitting existing critical facilities, including reservoirs and pump stations, will help Salem reduce their vulnerability to seismic events.
• The Department of Geology and Mineral Industries (DOGAMI) Statewide Seismic Needs Assessment completed in 2007 of educational and emergency service facilities in Salem identified 53 structures with a high or very high likelihood of collapse in the event of a major earthquake. facilities should be retrofitted accordingly to reduce the likelihood of collapse should an earthquake occur.
</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">
• Use DOGAMI’s Seismic Needs Assessment of buildings in Salem to identify and prioritize buildings vulnerable to seismic events. Seek additional information from DOGAMI, if vulnerable reservoirs and pump stations are not included in the Seismic Needs Assessment.
• Identify and construct projects identified in Salem’s Capital Improvement Plan and other critical projects that mitigate vulnerability to earthquakes.
• Conduct and/or update engineering studies and master plans to identify vulnerabilities to earthquakes and identify improvements needed to mitigate risk.
• Coordinate with OEM and FEMA to determine funding for conducting seismic retrofit of buildings, infrastructures, and utilities.
</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="4">Emergency Management</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Natural Hazards Mitigation Committee, Community Development Department, Public Works</td><td colspan="3">FEMA, OEM, DOGAMI, School Districts</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">HMGP, BRIC, Oregon SRGP, Salem General Fund, Salem Impact Fees, Building and Planning Fees, Salem Stormwater Utility Fees, Salem GO Bond</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP</td></tr>
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<table>
<tr><th colspan="3">Action Item: Earthquake #2</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Stay informed of the school districts plans about the identification and prioritization of school district facility retrofits and upgrades.</td><td colspan="2">Goals 2 and 4</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">
Due to the high concentration of students and the relative vulnerability of that population, schools have large negative impacts from seismic events. Seismically retrofitting these facilities will significantly reduce their vulnerability in the event of an earthquake.
Oregon Senate Bill 3 (2005) enables the Oregon Office of Emergency Management to develop a grant program to seismically rehabilitate critical public facilities. While the grant program is still being developed, conducting an inventory of critical facilities early will assist communities in obtaining funding once the grant program is in place.
The Department of Geology and Mineral Industries (DOGAMI) Statewide Seismic Needs Assessment completed in 2007 of educational facilities in the state of Oregon identified 48 school structures with a high or very high likelihood of collapse in the event of a major earthquake. These facilities should be retrofitted accordingly to reduce the likelihood of collapse in the event of an earthquake.
The Disaster Mitigation Act of 2000 requires communities to identify comprehensive actions that protect new and existing buildings [201.6(c)(3)(ii)]. Seismically retrofitting existing critical facilities, including reservoirs and pump stations and especially schools, will help Salem reduce their vulnerability to seismic events.
</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">
Use DOGAMI's Seismic Needs Assessment of Salem school facilities to identify and prioritize school district facilities that are vulnerable to seismic events.
Educate school district officials about the effectiveness of natural hazard mitigation actions.
Coordinate with OEM and FEMA to seek funding for conducting seismic retrofit of buildings.
Engage the members of the school district with the Salem Natural Hazards Mitigation Committee.
</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="4">Emergency Management</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Natural Hazards Mitigation Committee, Community Development Department,</td><td colspan="3">FEMA, OEM, DOGAMI, Salem-Keizer School District, private schools, Chemeketa C.C., Willamette University, Corban University</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">HMGP, BRIC, Salem General Fund, Salem Impact Fees, Building and Planning Fees,</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
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<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP</td></tr>
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<table>
<tr><th colspan="4">Action Item: Flood #1</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="4">Update, maintain, and implement flood actions via a floodplain management plan in accordance with FEMA's Community Rating System guidelines.</td><td colspan="2">Goals 3, 4 and 5</td></tr>
<tr><th colspan="6">Alignment with Existing Plans/Policies:</th></tr>
<tr><td colspan="6">Salem Floodplain Management Plan, Stormwater Master Plan</td></tr>
<tr><th colspan="6">Rationale for Proposed Action Item:</th></tr>
<tr><td colspan="6">Floodplain management for Salem is unique and warrants a separate public process to identify specific action items. Factors include involvement in the Community Rating System, Endangered Species Act and compliance with existing adopted plans.</td></tr>
<tr><th colspan="6">Ideas for Implementation:</th></tr>
<tr><td colspan="6">Continue 10-step process identified by FEMA. Salem's Public Works department completed a final Floodplain Management Plan in April 2018. In addition to this plan needing occasional updating and maintenance, the plan's Action Plan will need implementation.</td></tr>
<tr><th colspan="2">Coordinating Organization:</th><td colspan="4">Public Works</td></tr>
<tr><th colspan="3">Internal Partners:</th><th colspan="3">External Partners:</th></tr>
<tr><td colspan="3">Emergency Management, Fire, Operations and Engineering</td><td colspan="3">FEMA, DLCD, National Flood Insurance Program, Floodplain Management Committee</td></tr>
<tr><th colspan="3">Potential Funding Sources:</th><th colspan="2">Estimated cost:</th><th>Timeline:</th></tr>
<tr><td colspan="3">BRIC, FMA, DLCD Technical Assistance Grant, DLCD Community Grant, Salem General Fund, Salem Impact Fees, Building and Planning Fees</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><th>Form Submitted by:</th><td colspan="5">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><th>Action Item Status:</th><td colspan="5">Ongoing, revised from 2017 version of the NHMP</td></tr>
</table>

<table>
<tr><td colspan="3">Action Item: Flood #2</td><td colspan="2">Alignment with Plan Goals:</td></tr>
<tr><td colspan="3">Improve and maintain the City of Salem’s National Flood Insurance Program (NFIP) Community Rating System (CRS) rating in order to reduce flood risk and NFIP premiums.</td><td colspan="2">Goals 2, 3, 4, 5, 6 and 7</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5">Stormwater Master Plan, Capital Improvement Plan (CIP)</td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">
• The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, insurance premiums under the NFIP are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance.
• In late 2021, FEMA upgraded Salem from Class 5 to Class 4 CRS program. Implementing action items to improve the CRS rating will significantly reduce NFIP premiums on structures located within the floodplain.
• The Disaster Mitigation Act of 2000 requires communities to identify mitigation actions that address existing buildings and infrastructure [201.6(c)(3)(ii)]. Maintaining the status of the Community Rating System program can help the community to enhance mitigation efforts and decrease the vulnerability to floods. In addition, the Flood Mitigation Assistance Program requires that communities maintain their compliance with the NFIP.
</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">
• Coordinate with the Department of Land Conservation and Development (DLCD) and FEMA to maintain the Community Rating System.
• Educate businesses and homeowners currently under the NFIP program about the CRS program and any mitigation actions they can implement to reduce their insurance premiums.
• Identify homes not in the NFIP that should have flood insurance.
• Develop mitigation activities to address repetitive and single loss flood properties in Salem.
• Identify and construct projects within Salem’s Capital Improvement Plan and other critical projects that address flood risk.
• Conduct and/or update engineering studies and master plans to identify flood risk and identify improvements needed to mitigate that risk.
</td></tr>
<tr><td colspan="2">Coordinating Organization:</td><td colspan="3">Public Works</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Community Development</td><td colspan="3">DLCD, National Flood Insurance Program, FEMA, Marion and Polk Counties</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">Salem General Fund, Salem Impact Fees, Building and Planning Fees</td><td colspan="2">TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP</td></tr>
</table>

<table>
<tr><th colspan="3">Action Item: Landslide #1</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Maintain landslide overlay maps using Light Detection and Ranging (LIDAR) data.</td><td colspan="2">Goal 4</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">LIDAR (Light Detection and Ranging) is a new tool that can provide very precise, accurate, and high-resolution images of the surface of the earth, vegetation, and the built environment. The data are collected with aircraft-mounted lasers capable of recording elevation measurements at a rate of 2,000 to 5,000 pulses per second and have a vertical precision of 15 centimeters (6 inches). LIDAR mapping increases the ability to identify areas that are prone to landslides.
In 2007, the Oregon Legislature Assembly directed DOGAMI to extend LIDAR collection efforts throughout the state. The goal is to provide high-quality LIDAR coverage for the entire state.</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">Contact DOGAMI and provide a map of Salem along with an estimate of available funding.
Seek funding opportunities with DOGAMI to conduct LIDAR mapping for Salem.
Once mapping is complete assess the need to update landslide ordinances.
Explore potential cost-sharing agreements with Keizer, Turner, Marion and Polk Counties for LIDAR mapping of the entire Salem-Keizer urbanized area.</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="4">Public Works Department</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Natural Hazards Mitigation Committee, City of Salem GIS technicians</td><td colspan="3">FEMA, NOAA, DLCD, DOGAMI, Keizer, Turner, Marion County, Polk County</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="2">HMGP, BRIC, Risk MAP, National Science Foundation DRMS, Salem General Fund, Salem Impact Fees, Building and Planning Fees, Salem SDCs</td><td colspan="2"></td><td>☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP as an ongoing action</td></tr>
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<table>
<tr><th colspan="3">Action Item: Landslide #2</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Utilize the updated regional landslide risk maps (DOGAMI O-16-02) to identify hazard areas and collaborate with the Oregon Department of Geology and Mineral Industries to work on landslide risk reduction efforts; determine areas buildings, infrastructure, and utilities at risk to landslides and incorporate and utilize updated data when reviewing development applications.</td><td colspan="2">Goal 2, 3 and 4</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5">Comprehensive plans, Lidar data available from DOGAMI, Capital Improvement Plan</td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">The risk assessment identified the potential for landslides to cause damage to buildings and infrastructure within Salem; landslides may cause road closures and interruptions to utility services. The risk assessment also identified previous incidents of landslides that affected the city. Road closures sometimes force residents to find alternate transportation routes. Review and monitor existing public infrastructure to identify specific exposure to landslide risk.

The Disaster Mitigation Act of 2000 requires communities to identify actions and projects that reduce the effects of hazards on both new and existing buildings and infrastructure [201.6(c)(3)(ii)]. Identifying existing public infrastructure with exposure to landslide risk will allow the implementation of mitigation measures to reduce this risk.</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">• Utilize the Landslide Susceptibility Map and Data (DOGAMI O-16-02) to perform landslide risk analysis. Use the new information to prioritize risk reduction actions. Perform risk reduction. Update/ develop Landslide Ordinances as applicable.
• Identify and construct projects identified in the City’s CIP and other critical projects that address buildings, infrastructure, and utilities’ vulnerability to landslides.
• Conduct and/or update engineering studies and utility master plans to identify vulnerabilities to landslides and identify improvements to infrastructure needed to mitigate that risk.</td></tr>
<tr><td colspan="2">Coordinating Organization:</td><td colspan="3">Community Development, Public Works</td></tr>
<tr><td colspan="3">Internal Partners:</td><td colspan="2">External Partners:</td></tr>
<tr><td colspan="3">GIS and Mapping, Emergency Management</td><td colspan="2">DOGAMI, DLCD</td></tr>
<tr><td colspan="3">Potential Funding Sources:</td><td>Estimated cost:</td><td>Timeline:</td></tr>
<tr><td colspan="3">BRIC, HMGP, Risk MAP, National Science Foundation DRMS, Salem General Fund, Salem Impact Fees, Building and Planning Fees, Salem SDCs</td><td>TBD</td><td>☒ Ongoing
☐ Short Term (0-2 years)
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☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP</td></tr>
</table>

Action Item: Volcano #1	Alignment with Plan Goals:
Evaluate the impact of ash fall-out on HVAC systems in critical facilities. The City of Salem could benefit from a quick sheet on this topic; guidance to contractors for maintenance.	Goals 2, 3 and 4

Alignment with Existing Plans/Policies:

Emergency Operations Plan

Rationale for Proposed Action Item:

Because volcano ash has not affected Salem since the 1980's, no planning has occurred on the effect it might have on the HVAC systems. The use of HVAC systems is extensive throughout Salem. These systems are much more complicated today than they were in the 1980's, and for the most part cannot be shut down with the pull of a switch. Salem needs to have a better understanding of the response procedures at each facility and then how we will recover from an event.

Ideas for Implementation:

Use the NHMP to identify where volcano ash might most likely come from and affect the City of Salem.
Determine when it might most likely take place.
Evaluate each facility to determine where ash might most likely impact that facility.
Determine what mitigation action might need to be taken for each facility.
Perhaps prepare a 2-page flyer that outlines what the public, building maintenance, or contractors maintaining the city's facilities should do in this sort of emergency.

Coordinating Organization:	Emergency Management

Internal Partners:	External Partners:
All City Departments	DEQ, DOGAMI

Potential Funding Sources:	Estimated cost:	Timeline:
HMGP, BRIC, EPA Community Action for a Renewed Environment, EPA Air Grants and Funding, Salem General Fund, Salem Impact Fees, Salem SDCs, Salem GO Bond	TBD	☐ Ongoing ☐ Short Term (0-2 years) ☒ Mid-Term (3-5 years) ☐ Long-Term (5+ years)

Form Submitted by:	Salem Natural Hazards Mitigation Committee (2023)
Action Item Status:	New

<table>
<tr><th colspan="3">Action Item: Wildfire #1</th><th colspan="2">Alignment with Plan Goals:</th></tr>
<tr><td colspan="3">Conduct wildfire prevention outreach, as outlined in the Marion County and Polk County (West Salem) Community Wildfire Protection Plans (CWPPs), to residents near the wildland-urban interface.</td><td colspan="2">Goals 1, 2, 4, 5 and 7</td></tr>
<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5">• The Oregon Department of Forestry (ODF) completed a Communities at Risk Assessment for Salem that shows areas in northwest and south Salem that are at high risk to wildfire events. These areas are just outside of Salem but are vulnerable to wildfire events that could impact residents within the city. Conducting wildfire prevention outreach to residents near these areas can significantly reduce the vulnerability of the neighborhoods to wildfire events.
• Interviews with Salem Fire Department staff indicate that the areas with the highest risk have the steepest slopes, the right fuels, and high valued property. The areas outlined by the ODF Communities at Risk Assessment show that many of the areas at risk are near steep slopes and have combustible fuels. Conducting wildfire prevention outreach can help to reduce vulnerability of residents to wildfire events.
• The Marion County and Polk County CWPPs outline strategies for conducting wildfire prevention outreach to residents living in the wildland-urban interface. Conducting wildfire prevention outreach using the CWPP will help to integrate mitigation into existing plans and policies as required by the Disaster Mitigation Act of 2000 [201.6(c)(4)(ii)].
• The Disaster Mitigation Act of 2000 requires communities to identify mitigation actions that address new and existing buildings and infrastructure [201.6(c)(3)(ii)]. Conducting wildfire prevention outreach measures will help to protect new and existing buildings from wildfire.</td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5">• The Marion and Polk County CWPPs contain several action items for reducing the impacts of wildfire on communities throughout the city, including actions to conduct public outreach about fuels reduction and defensible space. Using these action items can assist in reducing the impact of wildfire on Salem.
• Coordinate with responsible agencies listed in the CWPPs to implement action items.</td></tr>
<tr><td>Coordinating Organization:</td><td colspan="4">Salem Fire Department</td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2">Public Works and Community Development Departments, Police Department, Community Services</td><td colspan="3">Oregon Department of Forestry, Marion County Fire District #1, Salem Suburban Fire District, Neighborhood Associations</td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td>Estimated cost:</td><td colspan="2">Timeline:</td></tr>
<tr><td colspan="2">USDA Community Wildfire Defense Grant Program, Fire Prevention and Safety Program, National Fire Plan, FMAG, BRIC, OR Community Risk Reduction Grants, OR Landscape Resiliency Program, Salem General Fund, Salem Impact Fees, RARE Program</td><td>TBD</td><td colspan="2">☒ Ongoing
☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4">Salem Natural Hazards Mitigation Committee</td></tr>
<tr><td>Action Item Status:</td><td colspan="4">Ongoing, revised from 2017 version of the NHMP</td></tr>
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Appendix A-3: Action Item Form

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<tr><th colspan="3">Action Item:</th><th colspan="2">Alignment with Plan Goals:</th></tr>
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<tr><td colspan="5">Alignment with Existing Plans/Policies:</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Rationale for Proposed Action Item:</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Ideas for Implementation:</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="2">Coordinating Organization:</td><td colspan="3"></td></tr>
<tr><td colspan="2">Internal Partners:</td><td colspan="3">External Partners:</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td colspan="2">Potential Funding Sources:</td><td colspan="2">Estimated cost:</td><td>Timeline:</td></tr>
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☐ Short Term (0-2 years)
☐ Mid-Term (3-5 years)
☐ Long-Term (5+ years)</td></tr>
<tr><td>Form Submitted by:</td><td colspan="4"></td></tr>
<tr><td>Action Item Status:</td><td colspan="4"></td></tr>
</table>

APPENDIX B: PLANNING AND PUBLIC PROCESS

Purpose

This Appendix describes the process of updating the plan, how the plan was prepared, who was involved, and specific changes made to the *2017 Salem Natural Hazards Mitigation Plan (NHMP)* during the plan update process that resulted in the *2023 Salem NHMP*. Major changes are documented by plan section.

Background

Salem partnered with Oregon Department of Land Conservation and Development (DLCD) through funding by Federal Emergency Management Agency (FEMA) to update the *2017 Salem NHMP*. The Disaster Mitigation Act of 2000 requires communities to update their mitigation plans every five years to remain eligible for FEMA Hazard Mitigation Assistance funding, which includes the following programs: Building Resilient Infrastructure and Communities Program (BRIC), Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Fire Management Assistance Grant (FMAG) Program, Public Assistance (PA) Grant Program, Rehabilitation of High Hazard Potential Dam (RHHPD) Grant Program, and Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) Revolving Loan Fund. DLCD Project Manager met with members of the Salem steering committee to update their NHMP. DLCD Project Manager and the committee made several changes to the previous NHMP. Major changes are documented and summarized in this memo.

DLCD staff worked with City of Salem's Emergency Manager, to form the City of Salem NHMP Steering Committee (the Steering Committee) intended to represent the whole community. The Steering Committee included representatives from the various city departments, state agencies, police and fire departments, public transportation district, public utility companies, one public school district, community college and universities, state agencies, neighboring jurisdictions (one city and one county), religious and nonprofit organizations, a watershed council, SAIF insurance and Red Cross. Numerous other community organizations[14] and the Chemawa Indian School[15] were contacted and invited to join the process, not all were able to participate directly.

The DLCD Natural Hazards Planner, Cynthia Smidt, managed the project and met with members of the Steering Committee ten times and conducted individual phone conversations and email conversation to guide Steering Committee work on the plan update. The Steering Committee included regular participation from city departments and

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[14] These included several nonprofit organizations that represented the socially vulnerable and under-represented members of the community. These organizations were able to attend at least one meeting for their respective organization.

[15] Chemawa Indian School, https://chemawa.bie.edu/#

the interested parties noted above. A list of the Steering Committee members and other participants is on page B-12.

A multi-hazard risk analysis was performed by the Oregon Department of Geology and Mineral Industries for Marian County, which included also included east Salem in Polk County, and an analysis of the potential future climate impacts to natural hazards was performed by the Oregon Climate Change Research Institute. Both are included in this NHMP update.

2023 Plan Update Changes

The sections below only discuss *major* changes made to the NHMPs during the 2022-2023 plan update process. Major changes include the replacement or deletion of large portions of text, changes to the plan's organization, updated hazard risk and vulnerability assessment, and new mitigation action items. If a section is not addressed in this memo, then it can be assumed that no significant changes occurred.

Table B-1 lists the *2017 Salem NHMP* plan section names and the corresponding 2023 section names, as updated. This appendix will use the 2023 plan update section names to reference any changes, additions, or deletions within the plan.

Table B-1 Changes to Plan Organization

2017 Salem NHMP	2023 Salem NHMP
Acknowledgements	Acknowledgements
Table of Contents	Table of Contents
Approval Letters and Resolutions	City of Salem Resolution and FEMA Approval
FEMA Review Tool	FEMA Review Tool moved to Appendix K
Volume I: Basic Plan	Volume I: Basic Plan
Plan Summary	Plan Summary combined with Section 1: Introduction
Section 1: Introduction	Section 1: Introduction
Section 2: Risk Assessment	Section 2: Risk Assessment
Section 3: Mitigation Strategy	Section 3: Mitigation Strategy
Section 4: Implementation and Maintenance	Section 4: Implementation and Maintenance
Volume II: Appendices	Volume II: Appendices
Appendix A: Action Items	Appendix A: Action Items
Appendix B: Planning Process and Public Process	Appendix B: Planning Process and Public Process
Appendix C: Community Profile	Appendix C: Community Profile
Appendix D: Economic Analysis	Appendix D: Economic Analysis
Appendix E: Grant Programs and Resources	Appendix E: Grant Programs and Resources
Appendix F: Lifeline Sector Analysis	Appendix F: Lifeline Sector Sums
Appendix G: Survey	Appendix G: DOGAMI Hazard Analysis
	Appendix H: OCCRI Future Climate Projections
	Appendix I: Acronyms
	Appendix J: References
	Appendix K: FEMA Review Tool

Front Pages

1. The plan's cover has been updated.
2. Acknowledgements have been updated to include the 2023 project partners and planning participants.
3. The City of Salem Resolution and FEMA approval letter are included.

Volume I: Basic Plan

Volume I provides the plan framework for the *2023 Salem NHMP* update, including the following sections:

Section 1: Introduction

The *2023 Salem NHMP*'s Section 1: Introduction includes an updated plan summary, which provides information about the purpose of natural hazards mitigation planning and describes how the plan will be implemented. In addition, Section 1 introduces the concept of natural hazards mitigation planning and answers the question, "Why develop a mitigation plan?" Additionally, Section I summarizes the 2023 plan update process and provides an overview of how the plan is organized.

Section 2: Risk Assessment

Section 2, Risk Assessment, consists of three phases: hazard identification, vulnerability assessment, and risk analysis. Hazard identification involves the identification of hazard causes and characteristics, geographic location and extent, identification of said hazard, history, future climate variability, probability of occurrence, and vulnerability assessment. The second phase attempts to predict how different types of property and population groups will be affected by the hazard. The third phase involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Changes to Section 2 include:

- The hazard chapters of the *2017 Salem NHMP* have been integrated into this section.
- Hazard identification, characteristics, history, probability, vulnerability, and hazard specific mitigation activities were updated, including the addition of two other hazards (air quality and water quality). Information previously provided in the Hazard Chapters is placed in this section. Additional information was added identification each hazard and future climate variability. Some extraneous information may have been removed and links to technical reports were added as a replacement.
- Links to new specific hazard studies and data are embedded directly into the plan where relevant and available.
- National Flood Insurance Program (NFIP) information was updated.
- Hazard Vulnerability Assessment was review and updated.

Section 3: Mitigation Strategy

This section provides the basis and justification for the mission, goals, and mitigation actions identified in the NHMP. Major changes to Section 3 include the following:

- Mission and Goals were reviewed and updated by the *2023 Salem NHMP* Steering Committee to align with other community objectives.
- The revision of existing actions and coordinating and partner organization designations were revised as applicable (as shown in Tables 24, 25, and 26 as well as in Appendix A).
- A list of prioritized actions for Salem, Table 25 (including new action item forms in Appendix A-1).
- The Steering Committee met to review the previous NHMP action items. Steering Committee members and stakeholders provided updates and edits to the actions where applicable.
- New action items are based upon continuous community needs, the identification of new hazards, deferred action items, and current needs based upon the community risk assessment. They are designed to be feasibly accomplished within the next five years, and can be found in Appendix A.
- Integration and the Existing Plans and Policies sections were updated with current information, including Table 28 (see also Table C-23).
- Mitigation Activities and Resources section added to show federal, state, and local mitigation resources, activities, and successes.

Section 4: Plan Implementation and Maintenance

The Steering Committee (also referred to as the Coordinating Body in this section) formally met once between 2018-2019, after FEMA approval of *2017 Salem NHMP*; however, meeting notes were unavailable. After this time, the committee did not formally meet since the COVID pandemic affected committee capacity. Progress towards action items is documented in the action item section below and in Appendix A, Action Items. The Steering Committee agreed to meet semi-annually, and the Salem Emergency Manager will be the plan convener. The steering committee will discuss options to integrate the NHMP into other planning documents during their semi-annual meetings.

Volume II: Appendices

Below is a summary of the appendices included in the *2023 Salem NHMP*:

Appendix A: Action Items

Action item forms were created for new actions, others have been updated to account for new information. The action item forms reference the status of the action item, timeline, rationale, implementation measures, coordinating and partner organizations, and potential funding sources. In Table B-2 below, it shows progress made towards previous plans' actions.

Appendix B: Planning and Public Process

This planning and public process appendix reflects changes made to the Salem NHMP and documents the 2022-2023 planning and public process.

Appendix C: Community Profile

The community profile has been updated to conform with the DLCD template and includes information for Salem.

Appendix D: Economic Analysis of Natural Hazard Mitigation Projects

Updates are provided for the economic analysis of natural hazard mitigation projects.

Appendix E: Grant Programs

The grant programs and resources has been updated, expanded, and reformatted to illustrate the numerous federal, state, and local programs and resources available in Oregon.

Appendix F: Lifeline Sector Assessment

This section remains unchanged except for the introduction paragraph and minor format and grammatical edits. This assessment is from the 2017 Marion County NHMP and provides in-depth risk and vulnerability information for four critical lifeline sectors identified by Marion County (as applicable to Salem): Transportation, Water, Energy, and Communication.

Appendix G: DOGAMI Multi-Hazard Risk Report for Marion County, Oregon

This new section contains the *Multi-Hazard Risk Report for Marion County, Oregon* by Oregon Department of Geology and Mineral Industries (DOGAMI). This report includes an analysis of Salem, including the western region that is in Polk County.

Appendix H: OCCRI Future Climate Projections Report

This new section contains the *Future Climate Projections Marion County, Oregon (2022)* report by the Oregon Climate Change Research Institute (OCCRI).

Appendix I: Acronyms

This new reference section includes common state and federal acronyms.

Appendix J: References

All cited material found in the *2023 Salem NHMP* are listed in this new appendix.

Appendix K: Federal Emergency Management Agency Review Tool

This new section contains the FEMA Review Tool.

Table B-2 2017 Salem NHMP Action Status

Mitigation Action ID	Priority	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	Status/Changes
Multi-Hazard						
MH #1	High	Identify and Designate Priority Transportation Routes.	Salem Public Works	Emergency Management, ODOT	Mid Term (3-5 Years)	Completed in 2020/Removed
MH #2	Action Pool	Coordinate with the Capitol Planning Commission to integrate natural hazard mitigation into State and City respective capital improvements.	Salem Community Development	Natural Hazards Mitigation Committee, FEMA, OEM, Campital Projects Advisory Board	Ongoing	Ongoing/Retained
MH #3	Action Pool	Develop an inventory of the number and type of critical facilities within the community that are at reasonable risk for each hazard type.	Salem Emergency Management	Natural Hazards Mitigation Committee, GIS, IT, FEMA	Short Term (0-2 years)	Ongoing/Modified
MH #4	Action Pool	Develop public outreach materials for all natural hazard risks addressed in the Salem Natural Hazards Mitigation Plan. Materials should include mitigation actions residents and businesses can implement to reduce their risk to natural hazards, and where they can obtain more detailed natural hazard information.	Salem Emergency Management, Salem Community Development, Salem Public Works	Salem Public Works, Community Development, FEMA, Oregon State Police, OEM, DLCD, DOGAMI	Ongoing	Completed/Modified as ongoing
MH #5	Action Pool	Include a post-disaster recovery and mitigation annex/appendix in the Salem Emergency Operations Plan that encourages property owners to incorporate retrofitting and mitigation measures in recovery efforts.	Salem Emergency Management	Natural Hazards Mitigation Committee, FEMA, Oregon State Police, OEM	Short Term (0-2 years)	Not Completed/Removed
MH #6	Action Pool	Ensure Unified Development Code (UDC) updates consider specific hazards when updating the Salem code for mitigating the location of future development in identified/mapped high hazard areas.	Salem Community Development	Salem Public Works, Natural Hazards Mitigation Committee, DLCD, FEMA	Ongoing	Ongoing/Retained
MH #7	Action Pool	Strengthen or replace unsafe public structures (especially facilities critical to disaster and post-disaster planning/response).	Salem Public Works	Salem Fire , Police , Community Development, Urban Development,and Administrative Services, FEMA, ODOT	Long Term (5+ years)	Progressing/Modified as ongoing
MH #8	Action Pool	Continue developing alert and warning systems to notify residents of incidents involving natural hazards and hazardous materials.	Salem Emergency Management	Salem Public Works, Police, GIS and Mapping, ODOT, FEMA, OSHA	Ongoing	Completed/Modified as ongoing

Table B-2 2017 Salem NHMP Action Status (continued)

Mitigation Action ID	Priority	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	Status/Changes
Multi-Hazard						
MH #9	Action Pool	Enhance hazard resistant construction methods (wind, winter storm, landslide, etc.) where possible to reduce damage to utilities and critical facilities. In part, this may be accomplished by encouraging electric utility providers to convert existing overhead lines to underground lines.	Salem Public Works	Salem Community Development , Emergency Management, GIS and Mapping, Public Utilities Commission, Pacific Power	Ongoing	Ongoing/Retained
MH #10	Action Pool	Integrate the Mitigation Plan findings into planning and regulatory documents and programs including the Comprehensive Plan (particularly Goal 7).	Salem Community Development	Salem Public Works, Emergency Management, City Administration	Ongoing	Ongoing/Retained
MH #11	Action Pool	Participate in assessments of the short and long term needs for sheltering access and functional needs populations for all hazards.	Salem Emergency Management	Marion County, Salem Community Development, Oregon Department of Human Services	Short Term (0-2 years)	Progressing/Modified as ongoing
Drought						
DR #1	Action Pool	Complete and implement the North Santiam Drought Contingency Plan	Salem Public Works	City Departments, Marion County Emergency Management, Santiam Water Control District, City of Stayton, Linn Soil & Water Conservation District, Norpac Foods, Inc., ODA, DEQ, ODF, North Santiam Watershed Council	Short Term (0-2 years)	Completed in 2017/Modified with plan update
Earthquake						
EQ #1	High	Develop an inventory of un-reinforced masonry structures and develop appropriate mitigation action items to reduce the impacts of seismic events.	Salem Community Development Department	Urban Development, Public Works, Fire, FEMA, DOGAMI	Mid Term (3-5 Years)	Not Completed/Removed
EQ #2	High	Identify, inventory, and mitigate (as prioritization and resources allow) critical facilities and utilities that require seismic retrofit (consider structural and non-structural retrofit options).	Salem Emergency Management	Natural Hazards Mitigation Committee, Community Development Department, Public Works, FEMA, OEM, DOGAMI, School Districts	Ongoing	Ongoing/Retained
EQ #3	High	Create a bridge prioritization inventory based on major lifeline routes including state highways, routes, and major road arteries.	Salem Public Works/GIS	Salem Emergency Management, ODOT	Mid Term (3-5 Years)	Completed/Modified as multi-hazard action
EQ #4	High	Collaborate with SEDCOR to develop relevant public-private partnerships with businesses that can contribute to mitigation, response, and recovery.	Salem Public Works	Urban Development, Marion County Emergency Management, SEDCOR, Regional Solutions, UO EDAUC	Mid Term (3-5 Years)	Not Completed/Removed

Table B-2 2017 Salem NHMP Action Status (continued)

Mitigation Action ID	Priority	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	Status/Changes
Earthquake						
EQ #5	High	Partner with the school districts to help identify and prioritize seismic retrofits to school district facilities.	Salem Emergency Management	Natural Hazards Mitigation Committee, Salem Community Development, FEMA, OEM, DOGAMI, Salem-Keizer School District, private schools, Chemeketa C.C., Willamette Uniersity, Corban University	Short Term (0-2 years)	Progressing/Modified as ongoing
Extreme Heat						
EH #1	No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies.					
Flood						
FL #1	Action Pool	Update, maintain, and implement flood actions via a floodplain management plan in accordance with FEMA's Community Rating System guidelines.	Salem Public Works	Salem Emergency Management, Fire, Operations and Engineering, FEMA, DLCD, NFIP, Floodplain Management Committee	Ongoing	Completed in 2018/Modified as ongoing
FL #2	Action Pool	Improve the City of Salem's National Flood Insurance Program (NFIP) Community Rating System (CRS) rating in order to reduce flood risk and NFIP premiums.	Salem Public Works	Salem Community Development, DLCD, NFIP, FEMA, Marion and Polk Counties	Ongoing	Completed/Modified as ongoing
Landslide						
LS #1	Action Pool	Map areas of landslide risk adjacent to the North Santiam River (upstream of the Geren Island water intake structures) and areas impacted by a catastrophic failure of the Detroit or Big Cliff Dams.	Salem Public Works	Salem Communitiy Development, DOGAMI, US Army Corp, DLCD, FEMA, BLM, USFS	Long Term (5+ years)	Partially Completed/Removed
LS #2	Action Pool	Update landslide overlay maps using Light Detection and Ranging (LIDAR) data.	Salem Public Works	Natural Hazards Mitigation Committee, GIS and Mapping, FEMA, NOAA, DLCD, DOGAMI, Cities of Keizer and Turner, Marion and Polk Counties	Long Term (5+ years)	Completed/ Modified as ongoing
LS #3	Action Pool	Utilize the updated regional landslide risk maps (DOGAMI O-16-02) to identify hazard areas and collaborate with the Oregon Department of Geology and Mineral Industries to work on landslide risk reduction efforts; determine areas and buildings at risk to landslides; and propose Comprehensive Plan and land use policies accordingly.	Salem Community Development	Salem GIS and Mapping, Emergency Management, DOGAMI, DLCD	Short Term (0-2 years)	Progressing/Modified as ongoing

Table B-2 2017 Salem NHMP Action Status (continued)

Mitigation Action ID	Priority	Mitigation Action Title	Lead Entity	Partners Organization(s)	Timeline	Status/Changes
Volcano						
VE #1	No specific action item developed for this hazard. See multi-hazard actions for applicable mitigation strategies					
Windstorm						
WD #1	Action Pool	Partner with public and private utilities to educate the public about hazardous trees and the damage they can cause in the event of a windstorm.	Salem Public Works	Salem Community Services, Parks Operations, Fire Department, ODOT, Portland General Electric, Electric Utilities	Ongoing	Ongoing/Modified as a multi-hazard action
Winter Storm						
WT #1	Action Pool	Partner with public and private utilities to educate the public about hazardous trees and the damage they can cause in the event of a winter storm.	Salem Public Works	Salem Community Services, Parks Operations, Fire Department, ODOT, Portland General Electric, Electric Utilities	Ongoing	Ongoing/Modified as a multi-hazard action
Wildfire						
WF #1	Action Pool	Conduct wildfire prevention outreach, as outlined in the Marion County and Polk County (West Salem) Community Wildfire Protection Plans (CWPPs), to residents near the wildland-urban interface.	Salem Fire Department	Salem Public Works, Community Development, Police, Community Services, ODF, Marion County Fire District #1, Salem Suburban Fire District, Neighborhood Associations	Ongoing	Completed/Retained as ongoing
Hazardous Materials Incident						
HM #1	Action Pool	Map facilities that handle or contain hazardous materials, rank them based on their level of risk, and refine response strategies for each situation in the event of an accident.	Salem Fire Department	Salem Emergency Management, Public Works, OSHA, Chamber of Commerce, Neighborhood Associations, ODOT, OEM, Oregon State Police, Oregon State Fire Marshall	Short Term (0-2 years)/Ongoing	Not Completed/Removed

Source: Salem Steering Committee, updated 2023

Action ID Key: MH=Multi-hazard, DR=Drought, EQ = Earthquake, EH=Extreme Heat, FL = Flood, LS=Landslide, HM=Hazardous Materials Incident, VE=Volcano Event, WD=Windstorm, WT=Winter Storm, WF=Wildfire

Public Participation Process

2022-2023 NHMP Update

The City of Salem is dedicated to directly involving the public in the review and update of the NHMP. Although members of the Steering Committee represent the public, Salem community members were also given the opportunity to provide feedback about the NHMP through personal communication by representatives on the Steering Committee, through the webpage dedicated to NHMP updates located on the City of Salem's Emergency Management webpage and through social media postings. In addition, the public will be involved during the semi-annual implementation and maintenance.

As described in Volume I: Plan Implementation and Maintenance, the NHMP will undergo formal review on a semi-annual basis (twice per year).

The City of Salem Emergency Manager posted notification of steering committee meetings on the department's webpage. Associated with the draft risk assessment, a flyer was developed by the Project Manager and posted online in two languages (English and Spanish). Participation by the public and feedback on the NHMP draft risk assessment and mitigation strategy was solicited by social media. During the drafting process Brian Carrara, Salem Fire Administrative Chief, together with Trevor Smith, Public Works Public Information Officer, made the draft Salem NHMP available via Salem's websites prior to final submission to FEMA Region X and Oregon Department of Emergency Management.

Public Involvement Summary

Salem provided a press release on June 20, and placed an article in the city newsletter and announced the plan on its social media (Facebook, June 21 and earlier) to inform the public that an update to the NHMP was occurring and to take a survey and provide an opportunity for the public to learn more about the update and comment.

There were no comments received during the public review period via the OPDR project page for the Salem NHMP update. Members of the steering committee provided edits and updates to the NHMP during this period as reflected in the final document.

Keeping in mind the importance of representing the whole community, the Salem NHMP Steering Committee was assembled by Greg Walsh, City of Salem Emergency Manager (former), and Cynthia Smidt, DLCD Natural Hazards Planner. A broad range of city departments, agencies, and other organizations were solicited for potential participation. Opportunity to participate as a member of the Steering Committee was extended via email or phone call, to representatives of Marion and Polk counties, Cities of Keizer and Turner, educational institutions, public transportation, utility companies, sewer and water users, conservation interests, and other local and state agencies involved in hazard mitigation and agencies that have the authority to regulate development. Numerous community organizations, which included representatives of socially vulnerable and underserved populations in the Salem community, and the Chemawa Indian School were contacted and invited to join the process. The following organizations that represent socially vulnerable and underserved populations, were invited to participate either through email or direct phone call. Not all were able to participate directly. However, there were some organizations that participated and contributed to the development of the *2023 Salem NHMP*, including mitigation actions that target socially vulnerable and underserved populations.

Chemawa Indian School: Chemawa Indian School is currently over 125 years old and is the oldest, continuously operated boarding school for Native American students in the United States. The school strives to maintain the highest academic standards and foster excellent educational opportunities for American Indians and Alaska Natives.

Mano A Mano Family Center: Mano a Mano was established in 1988 and is the oldest Latino and immigrant-led community-based organization in the Salem-Keizer area. They reach over 3,000 families annually, who live in Marion, Polk, and six other counties in Oregon. Mano A Mano connects with people to help in times of need and help develop healthy social connections. They also provide support to help the positive development of children and youth.

Marion Polk Food Share: Marion Polk Food Share's mission is to bring people together to end hunger and its root causes. They distribute nutritious food for individuals and families to more than 100 local partners, including food pantries and meal sites, and deliver Meals on Wheels to homebound seniors and adults with disabilities. They also operate an urban farm and support a network of community gardens that connect people and their food and mobilize community members to address systemic issues that lead to hunger.

Mid-Willamette Valley Community Action, The ARCHES Project: A multifaceted program for housing instability and homelessness. The ARCHES Project helps clients navigate from homelessness to stable housing and better lives, with an approach that provides referrals, housing placements, and basic services to people experiencing homelessness and housing instability in Marion and Polk counties.

Red Cross: Red Cross provide response, relief and recovery services; save lives through health and safety training; provide assistance to active military members, their families and local veterans; and ensure there is a safe and stable blood supply maintained for patients in need.

SAIF insurance: SAIF is Oregon's not-for-profit workers' compensation insurance company. Since 1914, we've been taking care of injured workers, helping people get back to work, and keeping rates low by focusing on workplace safety. Together with our partners, we strive to make Oregon the safest and healthiest place to work.

Salem Leadership Foundation / Church of the Park: The Salem Leadership Foundation works to find individuals who understand that real change only happens when addressing both the social and spiritual issues facing the Salem area. Their mission is to engage people-of-faith and people-of-goodwill to transform the community for good—neighborhood by neighborhood.

The members of the Steering Committee volunteered their time to provided edits and updates to the NHMP during publicly advertised meetings and on an individual basis such comments being vetted in a public forum before inclusion in the document. Opportunities for the public to comment were provided during the draft risk assessment and mitigation strategy, which were both posted on the Salem Emergency Management webpage.

Salem NHMP Steering Committee Members

These representatives served as Steering Committee members for the City of Salem Natural Hazards Mitigation Plan update process. Greg Walsh, Salem Emergency Manager was the convener of the Steering Committee for the first half of the process, prior to his departure from the City of Salem. Brian Carrara, Salem Fire Administrative Chief, convened the committee during the latter half of the process. Some representatives served successively as staff turnover required.

<u>Oregon Department of Land Conservation and Development</u>

Cynthia Smidt	Natural Hazards Planner, Planning Manager
Melissa Ahrens	Regional Representative

<u>City of Salem</u>

Greg Walsh	Emergencies & Disaster Preparedness, Emergency Manager, Convener (former)
Brian Carrara	Salem Fire Department, Deputy Chief of Administration, Convener
Anthony Gamallo	Public Works, Senior Transportation Planner
Austin Ross	Community and Urban Development, Planner II
Brandon Ditto	Salem Police, Professional Standards and Training Lieutenant
Courtney Knox Busch	City Manager's Office, Manager
Daniel Brown	Enterprise Services, GIS Manager
Devin Doring	Public Works, GIS Supervisor
Eunice Kim	Community and Urban Development, Long Range Planning Manager
Heather Dimke	Public Works, Climate Action Plan Manager (Management Analyst II)
Irma Coleman	City Manager's Office, Neighborhood Program Coordinator
Jennifer Mongolo	Public Works, Natural Resources Planner III
Joe Hutchinson	Emergencies & Disaster Preparedness, Emergency Manager
Mark Becktel	Public Works, Assistant Director
Patricia Farrell	Public Works, Climate Action Plan Manager (former) (Parks and Natural Resources Planning Manager)
Rebai Tamerhoulet	Community and Urban Development, Building and Safety Division Administrator and Salem Building Official (former)
Robert Romanek	Community Services, Planner
Ryan McGraw	Community and Urban Development, Building and Safety Division Engineer and Plan Review Supervisor
Treven Upkes	Salem Police, Lieutenant
Trevor Smith	Public Works, Public Information Officer
Zach Diehl	Public Works, Development Services Program Manager

<u>Chemeketa Community College</u>

John McIlvain	Emergency and Risk Management, Director

<u>Cherriots Transportation</u>

Randy Navalinski	Emergency Coordinator

City of Turner

Scott McClure	City Administrator

Mano A Mano Family Center

Lëvy Herrera-López	Executive Director

Marion County

Greg Walsh	Emergency Management, Director
Kathleen Silva	Emergency Management, Emergency Manager (former)

Mid-Willamette Valley Community Action, The ARCHES Project

Robert Marshall	Program Manager

Mid-Willamette Valley Council of Governments

Scott Whyte	Land Use Planner

North Santiam Watershed Council

Brandin Hilbrandt	Restoration Project Manager

Oregon Joint Operations Center

MAJ Vasilios (Bill) Garyfallou	Plans Officer/J7 Training
Shalee Meier	Emergency Management Specialist

Portland General Electric

John Plechinger	Business Continuity & Emergency Management, Team Lead
Corey Fisher	Business Continuity & Emergency Management, Consultant

Red Cross

Tanya Silva	Disaster Program Manager

SAIF Insurance

Rebecca Wale	Total Worker Health Advisor

Salem Keizer School District

Juan Benavidez	Emergency Manager

Salem Leadership Foundation, Church at the Park

Josh Erickson	Director of Operations

Willamette University

Andrew Fresh	Campus Safety & Emergency Management, Director
Ross Stout	Campus Safety & Emergency Management, Associate Director

Summary of Participation and Outreach

The following pages include copies of meeting agendas and approved meeting notes[16] from the Salem NHMP Steering Committee meetings. In addition, below there are website screenshots, social media posts, flyers, and other information that demonstrate the outreach efforts made during the NHMP update process. Table B- highlights important dates of the planning process

Table B-3 Salem NHMP Important Dates

Date	Description of Event or Activity
Ongoing	Salem existing webpages addressing preparedness and mitigation in hazard prone areas such as earthquakes, wildland urban interface wildfire, water and air quality information webpages
September 12, 2022	Salem City Council receive NHMP project report, agree to sign IGA
September 12, 2022	NHMP-specific webpage established; meetings viewable online
September. 29, 2022	Steering Committee Meeting #1
October 19, 2022	Steering Committee Meeting #2
November 15, 2022	Steering Committee Meeting #3
December 14, 2022	Steering Committee Meeting #4
January 26, 2023	Steering Committee Meeting #5
February 21, 2023	Steering Committee Meeting #6
April 19, 2023	Steering Committee Meeting #7
April - June 2023	Draft Risk Assessment document posted online for public review
April 24, 2023	Draft Risk Assessment flyer online (English and Spanish versions)
May 31, 2023	Steering Committee Meeting #8
June 1, 2023	Social media (Facebook) posting seeking input on draft risk assessment
June 1 – 23, 2023	Public comments requested and received.
June 12, 2023	Draft Mitigation Strategy document posted online for public review
June 12, 2023	Social media (Facebook) posting seeking input on draft mitigation strategy
June 26, 2023	Steering Committee Meeting #9
July 19, 2023	Steering Committee Meeting #10

[16] Meeting provided in Appendix B do not include attachments.

Steering Committee Meeting Agendas and Notes

Meeting #1

City of Salem Natural Hazard Mitigation Plan
Steering Committee Kick-off Meeting
AGENDA
Thursday, September 29, 2022
Time: 1300

Join Zoom Meeting
https://us02web.zoom.us/j/84024401956
Meeting ID: 840 2440 1956
One tap mobile
+17193594580,,84024401956# US
+12532158782,,84024401956# US (Tacoma)

Welcome and Introductions	
• Welcome • Introductions	Greg Walsh, City of Salem All
NHMP Purpose & Process	
• Purpose of NHMP updates • Project Components	Cynthia Smidt, DLCD
Roles of Participants	
• DLCD and City of Salem • Steering Committee – City of Salem department representatives • Stakeholders – Who will represent community members? • Cost Share • Box	Cynthia Smidt, DLCD
Public Engagement Strategy	
• Draft project schedule • Website and social media • Outreach and public engagement discussion	Cynthia Smidt, DLCD Greg Walsh, City of Salem All
Next Steps	
• Meeting schedule: Let's decide Steering Committee meetings • NHMP Review: Please review previous NHMP comments • Box: Get familiar with BOX program • Cost Share: Participants submit cost share monthly	Greg Walsh, City of Salem

Local Mitigation Planning Guide (revised April 19, 2022)
https://www.fema.gov/sites/default/files/documents/fema_local-mitigation-planning-policy-guide_042022.pdf

City of Salem Natural Hazard Mitigation Plan

Steering Committee Kick-off Meeting

MINUTES

Thursday, September 29, 2022

Time: 1300

Online via Zoom

Attendance: Participants from City of Salem included Gregory Walsh, Eunice Kim, Austin Ross, Anthony Gamallo, Zach Diehl, Jennifer Mongolo, Irma Coleman, Heather Dimke, Patricia Farrell, Brian Carrara, and Brandon Ditto. DLCD staff included Cynthia Smidt and Marian Lahav. Interested community partners included Kathleen Silva, Scott McClure, Randy Navalinski, Juan Benavidez, Rebecca Wale, Ross Stout, John McIlvain, Josh Erickson, Shalee Meier, and Tanya Silva.

Welcome and Introductions: Greg and Cynthia started the meeting with introductions. Everyone provided information in the Zoom chat (attached).

NHMP Purpose & Process: Cynthia provided a PowerPoint presentation going over the purpose of a NHMP update, project components, and schedule.

Roles of Participants: Cynthia provided an overview of the roles and responsibilities of both steering committee and stakeholders/interested parties. There was a brief discussion about what other participants could be invited. Information is in the Zoom chat. Cynthia also discussed the typical process for grant cost share, however, due to the generosity of the federal government (Consolidated Appropriations Act) and Oregon Legislature (House Bill 5006 enacted in the 2021 Regular Session), the City of Salem does not need to provide documentation of match to DLCD for this grant. Greg will provide city employees with the appropriate code for recording their time. Greg will also record other participants time, if necessary.

Public Engagement Strategy: Cynthia provided an overview of public engagement and then requested ideas. City of Salem has a current website that will be updated regularly at Natural Hazard Mitigation Plan Update 2022/23 | Salem, Oregon (cityofsalem.net). Participants were encouraged to send public engagement ideas to Greg or enter them into the Zoom chat.

Next Steps: Greg will send out a doodle poll to determine the next several months for meetings. Cynthia and Greg requested that participants review the current NHMP and the Focus Matrix. In addition, once Cynthia sends out invitations to Box, participants should get familiar with the program.

Attachments:

1. Zoom Chat
2. Zoom Attendance sheet
3. PowerPoint presentation

Meeting #2

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #2

AGENDA

Tuesday, October 19, 2022
Time: 1:00 – 3:00 p.m.

Join Zoom Meeting
https://us02web.zoom.us/j/84798171222
Meeting ID: 847 9817 1222
One tap mobile
+17193594580,,84798171222# US
+12532158782,,84798171222# US (Tacoma)

Introduction	**3 min**

- Introductions

Project Updates	**25 min**

- Meeting Notes
- Stakeholder/Interested Parties Roster
- Public Engagement Plan

Hazard Identification	**10 min**

- 2017 Natural Hazards
- 2023 Natural Hazards

Natural Hazard Events	**10 min**

- 2017-2022 Historical Events

DOGAMI & OCCRI Reports	**55 min**

- DOGAMI overview
- OCCRI overview and presentation

Next Meeting	**5 minutes**

- November 15, 2022 at 1:00-3:00 p.m.
    - Hazard Vulnerability Analysis
    - DOGAMI Presentation
- December 14, 2022 at 9:00-11:00 a.m.
    - TBD

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #2

MINUTES

Wednesday, October 19, 2022
Time: 1:00-3:00 pm

Online via Zoom

Attendance

Participants from City of Salem included Gregory Walsh, Mark Bectel, Austin Ross, Robert Romanek, Anthony Gamallo, Zach Diehl, Trevor Smith, Irma Coleman, Dan Brown, Heather Dimke, Ryan McGraw, Rebai Tamerhoulet, and Treven Upkes. DLCD staff included Cynthia Smidt. Interested community partners included Randy Navalinski, John Plechinger, Rebecca Wale, and Lëvy Herrera-López.

Welcome and Introductions

Greg and Cynthia started the meeting with introductions. Meeting attendance was documented using the chat function.

Project Updates/General Information

Meeting Minutes: Cynthia provided a summary of the September 29, 2022, meeting. Since committee members did not have much time to review the meeting minutes, the minutes will be reviewed for approval during the November 15, 2022 meeting. The Zoom chat includes Randy Navalinski and Greg discussing the need to correct spelling errors (e.g., Randy's last name and Corban University) in the minutes and presentation.

Stakeholder/Interested Parties: Cynthia provided the current roster of stakeholder/interested parties and asked for other suggestions of those organizations or individuals that this committee would benefit including. Dialogue ensued primarily on the Zoom chat between committee members and Greg. Irma also mentioned that she will share some new community contacts with Greg. Austin Ross will share some organizational contacts that were made during a City of Salem Planning-related project.

Dialysis centers? – Greg did reach out to folks in the dialysis field and waiting for a response.
Liberty House? Greg will reach out to Liberty House.

Public Engagement Plan: Cynthia provided an overview of those times the public will be engaged. However, more could be done. The committee discussed additional ideas.

Based on City of Salem's experience on a Planning Department project, Austin Ross emphasized that the NHMP committee look into what works for the community, not just for this committee. Therefore, he encouraged the committee to look at going to the community members, instead of having them to come to the committee. In addition, Austin will share some organizational contacts made during the City of Salem Planning-related project.

Randy Navalinski mentioned that there are a lot of events through organization such as Center 50+ and NorthWest Senior and Disability Services that might provide us with public outreach opportunities. Greg just had a conversation yesterday with Center 50+ and is a group he is interested in engaging.

Irma Coleman talked about a recent City of Salem survey that was conducted with city residents. The city wanted to learn from the community on how they like to receive news. Fifty-one to fifty-three percent prefer to receive emails. In addition, they receive information from the weekly Community Connections newsletter. The weekly Community Connections newsletter has already started sharing NHMP update information. Irma offered her assistance with interpretation and/or translation through her community connections. Irma also mentioned that she will share some new community contacts with Greg.

Cynthia mentioned that the committee needs to document all the public outreach that the committee is doing for the NHMP program. She said to provide screenshots, other images, documentation to Greg, Cynthia, or upload to Box.

In the Zoom chat, Daniel Brown said, “Depending on products and deliverables, if there are geographic indicators and visual stories to tell the community (maps, charts, reports, open data, and context) storymaps can be a digital tool for data understanding, survey, feedback, and storytelling.” Greg concurred.

Also in the Zoom chat, Robert Marshall told Greg that he is well connected with the Salem Police Department and homeless service providers and outreach teams. Robert continued, “I'm happy to help you set up public engagement events with providers that can assist us in getting information out to individuals experiencing homelessness, both sheltered and unsheltered.”

Hazard Identification

Cynthia briefly went over identifying natural hazards from 2017 City of Salem NHMP, the 2020 Oregon NHMP, and 2022 Marion County plans.

Regarding Hazardous Materials, which is listed in the 2017 plan, Cynthia provided options on how to approach this hazard seeing how it is not considered a “natural” hazard. Options include removing hazardous materials since it may already be addressed in another plan or keep it in the NHMP with/without edits. If the committee decides to keep it in the NHMP, Cynthia will not be able to work on that section due to FEMA grant restrictions. Greg mentioned that they are in the process of updating the City of Salem Emergency Management Plan, which has a Hazardous Material annex. However, Greg suggested that it remains in the NHMP since it as a compounding risk of other hazards. Cynthia suggested that Hazardous Materials information be moved under other natural hazards that are listed in the NHMP.

Other hazards to consider:

Greg suggested Solar Storm event, with power outages.

Randy suggested water source, algae blooms. Mark Bectel mentioned that Public Works just built a $40 million ozone treatment plant so they are hoping that will help with future algae blooms. However, they do need to make sure their plans are updated. The Public Works annex in the Emergency Management Plan does need to be updated. Otherwise, Mark felt the existing list is very comprehensive.

Mark added that although it is less likely a water quality event will occur again especially with the treatment plant, Salem is still vulnerable to contaminates in water. So, water quality might be still a hazard to consider. Greg concurred that water quality should be added to the list.

Heather Dimke asked about air quality via Zoom chat. Cynthia will look how air quality is addressed in other plans and whether they are listed as a standalone hazard.

Greg reminded everyone that having a hazard listed can open the door to mitigation grant funds

Natural Hazard Events

Cynthia briefly went over the last five years (May 1, 2017 to October 1, 2022) of recorded events based on NOAA Storm Event database. The committee can include everything or have the list be Salem-specific. However, the list should at least identify State Emergency Disaster Declarations and Federal Major Disaster Declarations that meet the FEMA "historic event" requirements. Regardless of whether these historic events effected the city, they still need to be identified in the NHMP.

Historic Events include the following:

- Emergency Operations Center (EOC) or alternate was activated
- Emergency Operations Plan (EOP), 3+ functions were implemented
- Extraordinary multi-jurisdictional response required
- Local or Tribal Emergency was declared

Greg can look at his list of emergency declarations to see if there is anything else. More importantly, looking at what affected Salem versus what affected Marion and Polk Counties.

DOGAMI & OCCRI Reports

DOGAMI: Cynthia provided a brief overview of the DOGAMI report. The DOGAMI report was conducted for Marion County and all of City of Salem. The report includes east and west sides of Salem, including that part of Salem located in Polk County. A video of the oral presentation by DOGAMI may be shown at the November meeting.

Randy asked about whether a critical facility is a county facility or a city facility. Greg discussed that they try to include both city and county in a variety of other things. Marion County NHMP was just completed their NHMP, and so a review of their plan can show how critical facilities and infrastructure are covered. Cynthia will also look into this and report back to the committee.

OCCRI: Cynthia provided a brief overview of the OCCRI report. The intent was to show the OCCRI presentation conducted in June to the Marion County's NHMP steering committee. However, the audio was not functioning after two attempts. Greg and Cynthia directed the committee to obtain the video from Box for viewing.

Next Meeting

November 15, 2022, at 1:00-3:00 p.m. Topics will include Hazard Vulnerability Analysis and DOGAMI Presentation
December 14, 2022, at 9:00-11:00 a.m.

Attachments:

1. Zoom Chat
2. Zoom Attendance image
3. PowerPoint presentation

Meeting #3

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #3

AGENDA

Tuesday, November 15, 2022
Time: 1:00 – 3:00 p.m.

Join Zoom Meeting
https://us02web.zoom.us/j/84798171222
Meeting ID: 847 9817 1222
One tap mobile
+17193594580,,84798171222# US
+12532158782,,84798171222# US (Tacoma)

Introduction	**3 min**
• Introductions	
General Updates	**15 min**
• Meeting Notes • BOX Assistance • Hazard Identification	
DOGAMI & OCCRI Reports	**55 min**
• OCCRI overview • DOGAMI overview and presentation	
Hazard Vulnerability Analysis	**30 min**
• HVA Introduction • Hazard Review	
Next Steps	**5 minutes**
• December 14, 2022 at 9:00-11:00 a.m. ▪ Hazard Vulnerability Analysis, *continued* • January-March 2023 – Doodle Poll • Public Engagement and Outreach	

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #3

MINUTES

Wednesday, November 15, 2022

Time: 1:00-3:00 pm

Online via Zoom

Attendance

Participants from City of Salem included Gregory Walsh, Mark Bectel, Austin Ross, Robert Romanek, Anthony Gamallo, Patricia Farrell, Irma Coleman, Daniel Brown, and Heather Dimke. DLCD staff included Cynthia Smidt, Katherine Daniel, and Melissa Ahrens. Interested community partners included Randy Navalinski, John McIlvain, Rebecca Wale, Lĕvy Herrera-López, and Corey Fisher.

Introduction and Meeting Objectives

Greg opened the meeting at approximately 1:00 p.m. and Cynthia called on participants to identify themselves as present in the Zoom meeting chat.

Cynthia reviewed the meeting objectives which included the following:

- Project Updates
- Hazard Vulnerability Assessment
- DOGAMI and OCCRI Reports
- Next Steps

Project Updates/General Information

Meeting Minutes: Since committee members did not receive the meeting notes from the September 29 and October 19 meetings, they will be reviewed for approval during the December 14, 2022 meeting. Cynthia also asked if anyone had recollection if Juan Beanidez, Salem-Keizer School District, was present at the October 19 meeting.

BOX Assistance: Cynthia let everyone know if they need assistance in the Box program, please let her know. Greg may be able to assist as well. Cynthia encouraged everyone to get into the program and look at the documents. Cynthia created a Meetings folder (higher tier folder) so committee members can go in there to see the draft minutes, agenda, PowerPoint presentations, and other information.

Hazard Identification: Cynthia requested clarification on three hazards – Air Quality, Water Quality, and Space Weather – that were discussed at the October 19, 2022 meeting.

Air Quality – Cynthia indicated that in certain areas where air inversions occur often, air quality has been identified as a primary hazard. Examples include City of Medford, Harney County, Burns Paiute Tribe. However, more often poor air quality is a consequent of another hazard and thus maybe considered a secondary hazard. An example of this would be air quality is affected by a wildfire.

Heather asked the question about air quality at the last meeting and stated that it makes sense that it is a secondary hazard. Patricia has addressed this as a secondary hazard related to wildfire in other situations.

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Greg felt the committee should continue to consider poor air quality as a secondary hazard to wildfire, for example. Austin pointed out that since the wildfire's are not in the region but from outside of the region, it seems that having it as a primary hazard would make sense.

Katherine, City of Albany discussed poor air quality as a hazard. Wallowa County has air inversions, so they called it out as a primary hazard. She also mentioned to look at considerations for the mitigation strategy whether wildfire smoke or volcanic ash. For example, does Salem have locations of refuges, with conditioned atmosphere. This will depend on how strongly you feel about this hazard.

Austin wasn't clear on the consequence of having air quality as a primary hazard versus secondary and how they are treated in the plan. He mentioned that if the committee chose to have it as a secondary hazard, but the plan doesn't have an associated mitigation strategy, then that would not be good for Salem. Moreover, if there are actions that address a secondary hazards, then maybe it's okay to have it as such. Cynthia told the group that the primary hazards identified in the plan need at least one mitigation action. The plan may address several secondary hazards under wildfire, for example, such as poor air quality, flooding, and debris flow. The plan can have mitigation actions for wildfire that address all those things. Alternatively, if air quality was listed as a primary hazard, those mitigation actions will be specific to air quality. Based on this information, Austin said he leans towards having air quality as a primary hazard because it is something the community will be dealing with more regularly in the future and having actions specific to air quality makes sense. Heather agrees with Austin in that the community will see it as a common occurrence in the future.

Greg asked Katherine for more about addressing mitigation strategies and Albany's approach. Greg wondering if a temporary shelter for cold/warm weather could also be used as smoke/air quality refuge, using the same action for multiple hazards. Katherine clarified that City of Albany did not list poor air quality as a primary hazard; however, they addressed it under wildfire. Nevertheless, Albany did have very poor air quality from the wildfires. Katherine confirmed that you can have provisions for a refuge that address multiple hazards. For example, a refuge might be used for poor air quality, extreme heat, or for individuals whose house was damaged from another hazard.

Austin suggested providing personal protection equipment (e.g., masks) as a mitigation strategy, making the equipment more available. He suggested encouraging retailers to sell masks for less or make more available for community members who do not make it to a refuge location.

Greg is not opposed to making air quality as a primary hazard so there are specific mitigation strategies for it. Through good engagement by the committee, there was agreement to have air quality (or poor air quality) as a primary hazard.

Water Quality – There was strong interest from the October 19 meeting to have water quality identified; however, Cynthia was seeking clarification. She cautioned the committee of having water quality as a primary hazard. Poor water quality is typically a consequence of other hazards such as flooding, post fire flooding or debris flows, and drought. However, sometimes listing it as a primary hazard may work in the situation of algal blooms. Patricia was wondering how the plan may address water quality that originate outside of the Salem area such as up the Santiam. Greg said this is something the city deals with regularly in Salem.

Mark mentioned that water quality has been a primary hazard in the past. There was a Water Quality Advisory in 2018 where water was distributed to vulnerable populations. This hazard was contributed to algae blooms and cyanotoxins in our watershed. He mentioned that mitigation is easier now with the new ozone treatment plan and there are backup measures as secondary mitigation.

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Katherine mentioned that if algae blooms are the primary source of the water quality issue, then list algae blooms as the hazard. She mentioned that even though you developed mitigation measures, the fact that Salem continues to pay attention to the problem is important to note. Mark indicated that it is in Salem's jurisdiction as they actively monitor the water quality at the reservoir and other locations multiple times a week. Salem monitors progress of algae blooms and cyanotoxins. However, Salem does not have legal jurisdiction as that falls upon Army Corp of Engineers. Salem also partners with a University of Oregon laboratory with the monitoring the watershed.

Katherine mentioned that Tillamook County identified algae blooms as a primary hazard, but it was not the impact on bivalves and oysters.

Greg wondering if it was appropriate to add water quality to the drought hazard. Patricia suggested addressing water quality and water quantity. Also, the restriction of water during an event. There is no causal relationship between algae blooms and water quantity, according to Mark. They are independent events.

Greg suggests that the plan list the hazard as a Water Emergency section and have subsections of water quality and water quantity. Alternatively identify it as Water Quality with subsections of algae blooms, drought, etc.

Cynthia indicated there is enough to work with at this time but will likely revisit it more in the future.

Space Weather – Greg mentioned solar storm or space weather as a possible hazard. Cynthia needed clarification on this one. Space Weather is a hazard identified on FEMA's site, but Cynthia is unsure whether a jurisdiction in Oregon has listed it in their plan. Greg mentioned that he hasn't had any real interactions with this hazard. Much of it affects power services and infrastructure. Mark mentioned that SCADA systems are important to their operations at public works. However, during temporary events, they can operate but it is done manually. Mark mentioned that if the event was an electromagnetic pulse (EMP) attack, things might be different. During the dialogue, Greg searched online the worse geomagnetic storms online and based on the information he is seeing, he does not think City of Salem needs to list this as a hazard in the plan.

Hazard Vulnerability Assessment

Cynthia gave an overview of the Oregon Department of Emergency Management's (OEM's) Hazard Vulnerability Assessment. The assessment very data driven; however, absent significant data, the review becomes subjective. The OEM methodology factors include history, probability, vulnerability, and maximum threat, which are further described as the following:

- *History* is a record of previous occurrences of natural hazards.
- *Probability* is the likelihood of future occurrence within a specific period of time.
- *Vulnerability* is the percentage of population and property likely to be affected under an "average" occurrence of the hazard.
- *Maximum Threat* is the highest percentage of population and property that could be impacted under a worst-case scenario.

Cynthia mentioned to the committee that each factor is weighted differently; however, the reason behind the weight is unclear to DLCD staff. The OEM documentation does not explain this information. Cynthia showed how probability and vulnerability were rated in the current NHMP. The presentation also included City of Salem's current Hazard Analysis Matrix, which showed total threat score, hazard rank, and hazard tiers. The committee then worked through each factor of the assessment for the Winter Storm hazard.

Regarding the *history* of winter storms, Mark said that they used to joke that Salem would have averaged a major ice or snowstorm (3-10 inches) every 4 years. In my past 20 years with the city, it is a roughly how often it does occur. He even mentioned Salem had a FEMA federal declaration for a 2021 winter storm. Greg agrees that Salem is seeing more of these storms more often. The city has increased its equipment to handle winter storm events. The Zoom chat has committee members rating the history of winter storm as high and 9. In addition, Corey Fisher (PGE) stated that the 2016-2017 winter "had a series of snowstorms back-to-back to back."

As for the *probably* of a winter storm event occurring, the committee agreed verbally and in the Zoom chat as high and rated it as 10. Randy provided feedback and agreed with Mark and Greg's comments of high probably, regardless of amount. Randy did mention that public transportation and Salem's Public Works teams can handle such an event; it is the public that cannot manage the snow and it can cause businesses to shut down.

The committee agreed that the *vulnerability* of a winter storm affecting Salem is high with a rating of 9. Greg believes this is "high" because it affects the entire community. Dan, Salem GIS, stated in the chat that "25% is 43,000 people." This percentage of population can include all the schools. Austin asked for clarification on what "affected" means. Cynthia said it includes everything whether it is school being canceled, people unable to go into work, tree falling on a house, or other carried over impacts.

The committee agreed that the *max threat* of a winter storm affecting Salem is high with a rating of 10. Greg mentioned that the recent winter storm that Salem had represented a worst-case scenario and he rates it as a 10. Mark agrees with a 10. Mark thinks the city may have lost over 10 percent of our tree canopy, although surveying is still underway. He also mentioned that many roads were blocked during the storm.

The following are the committee's ratings for Winter Storm (factor weights are not applied here):

HAZARD	HISTORY	PROBABILITY	VULNERABILITY	MAX THREAT
Winter Storm	9	10	9	10

The remaining hazards will be assessed during the December 14 meeting.

DOGAMI & OCCRI Reports

OCCRI: Cynthia mentioned that if anyone has not viewed or read the OCCRI report for Marion County it is available in Box under the Phase 2 folder under Risk Assessment.

DOGAMI: The DOGAMI report was conducted for Marion County and all of City of Salem. It is available in the Box Program. A video of the oral presentation by DOGAMI was shown at the meeting.

Next Meeting

The next meeting will be December 14, 2022. Cynthia mentioned that the committee will continue looking over the Hazard Vulnerability Assessment.

The meeting adjourned at 2:45 p.m.

Attachments:

1. Zoom Chat
2. PowerPoint presentation

4

Meeting #4

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #4

AGENDA

Wednesday, December 14, 2022

Time: 9:00 – 11:00 p.m.

Join Zoom Meeting
https://us02web.zoom.us/j/84798171222
Meeting ID: 847 9817 1222
One tap mobile
+17193594580,,84798171222# US
+12532158782,,84798171222# US (Tacoma)

Introduction	**3 min**
• Introductions	
Project Updates	**5 min**
• Meeting Notes • Public Engagement, Draft Risk Assessment	
Risk Assessment – *General*	**10 min**
• Community Profile Information	
Risk Assessment – *Hazard Vulnerability Assessment*	**60 min**
• HVA Reintroduction • Hazard Review	
Next Steps	**3 min**

• January-March 2023 Steering Committee Meetings – Doodle Poll
• Public Engagement and Outreach
  ▪ Draft Risk Assessment
  ▪ Any other events?	

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #4

NOTES

Wednesday, December 14, 2022
Time: 1:00-3:00 pm

Online via Zoom

Attendance

Participants from City of Salem included Gregory Walsh, Austin Ross, Robert Romanek, Anthony Gamallo, Zach Diehl, Patricia Farrell, Daniel Brown, and Heather Dimke. DLCD staff included Cynthia Smidt, Katherine Daniel, and Melissa Ahrens. Interested community partners included John Plechinger, John McIlvain, Rebecca Wale, and Bill Garyfallou.

Introduction and Meeting Objectives

Greg opened the meeting at approximately 9:00 a.m. and Cynthia called on participants to identify themselves as present in the Zoom meeting chat.

Greg and Cynthia reviewed the meeting objectives which included the following:

- Project Updates
- Risk Assessment: General
- Risk Assessment: Hazard Vulnerability
- Next Steps

Project Updates

Meeting Minutes: Prior to this meeting, the committee was provided the September 29, October 4, and November 15 meetings notes for review. Greg made a motion to approve the three meeting notes. John M. seconded the motion. The meeting notes were approved by a majority.

Public Engagement Plan: Cynthia mentioned that she is working on the draft Risk Assessment section of the NHMP so it can be available for public review in January sometime. She will work with Greg on getting that posted. Greg talked about his plan for online public engagement.

Risk Assessment: *General*

Community Profile: There are several areas of the community profile that will need to be reviewed and updated. Regarding *natural hazards*, Cynthia is looking for any existing plans, studies, reports, technical data and information for risk assessment for those non-DOGAMI reviewed hazards. This includes the following hazards:

- Water quality data and monitoring information
- Air quality data
- Drought
- Extreme Heat
- Hazardous Materials
- Windstorm
- Winter Storm

Cynthia will use some or all of what is in the existing plan, but additional or updated information may be needed. Cynthia requested that if anyone has additional information on any of these hazards, it would be

1

beneficial. Please either upload to Box or provide to Greg or Cynthia. Cynthia requests that this information be provided by the end of the year, if possible.

In the Zoom chat, Patricia said, "Public works has contracted with GSI to do drought monitoring in N. Santiam." Patricia previously sent Greg information on the North Santiam drought reports, which is part of the Drought Contingency Plan. In addition, Patricia said, "Justin Boyington in StormWater has 'microburst' information. He was trying to pull it together for the Climate Action Plan but wasn't able to, but he might have data now."

Regarding *critical facilities and physical infrastructure*, Cynthia is needing the steering committee or designated individuals to look over the 2017 Salem NHMP list (starts on page C-25, bottom of the page) and the 2022 DOGAMI list. Both documents were provided to the committee prior to the meeting. Greg and Daniel agreed to look over the list and/or organize a sub-group for review. Daniel mentioned via zoom, "I know we are in the middle of figuring out the "criticals", and I thought we would be finalizing this sometime in 2023."

Regarding other aspects of the community profile such as capabilities, changes in land use and development, changes in population, and NFIP Repetitive Loss and Severe Repetitive Loss Properties data are needed as well. Cynthia obtained the PSU population forecast but if there is any city data that can be helpful. Zach Diehl will work on getting the NFIP data. Austin is willing to getting land use and development changes data once he knows the parameters. Cynthia will revisit this information later.

Risk Assessment: *Hazard Vulnerability Assessment*

Cynthia refreshed the committee of the OEM Hazard Vulnerability Assessment, which includes the factors of history, probability, vulnerability, and maximum threat of a natural hazard. The committee worked through each factor of the assessment for the following hazards: air quality, drought, earthquake, extreme heat, flood, landslide, volcano, water emergency, [urban interface] wildfire, and windstorm. The winter storm hazard was reviewed during the November 15 meeting. The following are the committee's ratings for the reviewed hazards (factor weights are not applied here):

HAZARD	HISTORY	PROBABILITY	VULNERABILITY	MAX THREAT
Air Quality	9	10	9	10
Drought	4	9	5	9
Earthquake	3	9	8	10
Extreme Heat	10	10	10	10
Flood	10	10	5	9
Landslide	8	9	2	4
Volcano	2	2	2	10
Water Emergency	6	9	7	9
Wildfire	9	10	5	9
Windstorm	8	8	4	9
Winter Storm	9	10	9	10

2

This OEM methodology ranking is a tool representing the perspectives and experience of the group. Each hazard reviewed involved some discussion with the committee members. The following is just a highlight of some of those things discussed.

Windstorm: While addressing the windstorm hazard, the committee discussed how windstorm is defined and what is the threshold. Katherine indicated that it is a local perception to what causes damage with not specific mile-per-hour threshold. John M. provided the link to the National Weather Service's Graphical Hazardous Weather Outlook Severe Wind Threat description table. According to the NWS site, the Severe Wind Hazard map is "based on the likelihood that severe wind gusts will occur combined with the anticipated speed of the greatest gusts."(https://www.weather.gov/mlb/wind_threat) Patricia suggested looking into historical wind alerts from the NWS for Salem. John M. also provided a link to a 2019 KOIN News article (https://www.koin.com/weather/top-wind-storms-in-oregon-and-washington/) that showed the included notable windstorms from 1962 to 2019 (see image below). John P., PGE, talked about the cumulative impacts during bad storms that involve impacts not only to power but also telecommunications, infrastructure, and access (roads and other).

Wildfire: Although Salem has listed air quality as a stand-alone hazard, they reviewed poor air quality based on smoke as a consequence to wildfire that occurs in the Salem area. Smoke from fires in the region, but not necessarily occurring in the Salem area, would then be grouped under general air quality.

Water Emergency: The committee considered whether to include "boil water notices" as a threat to the community when they reviewed the OEM methodology. Greg indicated that previous water emergencies involved some level of monitoring and response and Emergency Operations Center activation. A "boil water notice" was typical of such emergencies.

In the chat, Zach Diehl mentioned that water emergency ratings could see an increase in the future if development is encouraged in the watershed. In addition, John M. said that another consideration regarding water emergency is how drought will impact water availability.

Melissa provided the following information in the chat.

> I have to take off but wanted to add a suggestion going back to the earlier conversation about resources: regarding water quality and drought vulnerability/hazards, USGS has chosen Willamette basin for the next Integrated Water Science Basin study. They mentioned that they welcome local and state partners to let them know where we want new modeling (esp. for human life/safety). They may have resources available or in progress. See more info here: https://www.usgs.gov/news/national-news-release/usgs-selects-willamette-river-basin-fourth-

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integrated-water-science. Point of contact was Rose Wallick, Oregon Water Science Center Email: rosewall@usgs.gov Phone: 503-251-3219

Volcano: Regarding ash fall, a consequence of a volcanic eruption, Greg mentioned (via online data) that when Mount St Helens erupted in 1980, most ash fell within 3 – 12 miles of the volcano; however, depending on the winds at the time, some ash was carried 150 miles southeast to Bend or 285 miles east to Spokane. Portland did receive a dusting and some ash fall occurred in the northern edge of Salem (approximately 90-100 miles southwest). Melissa noted in the chat that the Oregon HazVu doesn't show the Salem area within a volcanic high or moderate zone and thus impacts would be likely be air quality and/or water supply.

Landslides: It was noted by the committee that landslides often happen in the North Santiam Canyon and River Road. Katherine Daniel pointed out that "River Road is a principal transportation route, but there are alternatives." Melissa mentioned that DOGAMI's SLIDO (landslide viewer) shows a lot of potential slide areas.

Extreme Heat: The question from the committee was whether there was a definition of high heat. Cynthia mentioned that high heat is regionally dependent and what the community is used to. It was also mentioned that structures may not have been built to handle extensive heat and many people in the community do not have air conditioning. Patricia mentioned that they used this for looking at >90 degrees. She also shared the link of Portland temperatures from 1938-2022 as reported by the Oregonian: https://projects.oregonlive.com/weather/temps/. Mitigation strategies mentioned for this hazard included AC domes, cooling shelters (also proposed in Climate Action Plan), and tree cover.

Earthquake: Greg provided this link in the chat: https://survivingcascadia.com/37-in-50-years/. The site indicates the risk assessment is that there is a 37% chance in the next 50 years that there will be an earthquake in the region. Melissa provided this link in the chat regarding the amount of liquefiable soils in the city that can cause property damage: https://www.oregongeology.org/pubs/gms/gms-105_1.pdf. Daniel suggested looking up news stories on the Spring Break Quake of 1993.

Drought: The committee discussed how the city has mitigation measures (curtailing water use) in place. Although Salem has experienced drought, they may not be as vulnerable as other communities.

See comment by Melissa above under the Water Emergencies hazard regarding the Integrated Water Science Basin study.

Air Quality: Committee discussed air quality numbers. It was mentioned that vulnerable populations are affected at lower thresholds or differently. Businesses are also affected by poor air quality. Patricia said, "Maybe look at evenly affected vs disproportionate affect (seniors, children, low income) etc." when it comes to air quality. Heather responded, "Perhaps can be better called out/clarified in mitigation measures." Cynthia noted that some of this information can be highlighted in the community profile of the plan.

Patricia asked about how the OEM thresholds are set. Katherine mentioned it is unclear how the thresholds were set. Additionally, in the chat she said, "Impacts to vulnerable people in particular may not have been called out when this [OEM] methodology was developed. It is something we are more cognizant of today."

Melissa pointed out that there are some online mapping resources including the EPA's Environmental Justice Screening and Mapping Tool (https://ejscreen.epa.gov/mapper/).

Next Steps

Greg will send out a doodle poll to determine the next several months for meetings. The draft Risk Assessment is expected to be completed in January for public review.

The meeting adjourned at 2:30 p.m.

Attachments:

1. Zoom Chat
2. PowerPoint presentation

Meeting #5

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #5

AGENDA

Thursday, January 26, 2023

Time: 10:00 a.m. – 12:00 p.m.

Join Zoom Meeting

https://us02web.zoom.us/j/89253881633?pwd=L3htOEpwbE5BYjRxN1c4bGpMQ0VQZz09

Meeting ID: 892 5388 1633 | Passcode: Bv99ESM

One tap mobile

+12532158782,,89253881633#,,,,*5421775# US (Tacoma)

+13462487799,,89253881633#,,,,*5421775# US (Houston)

Welcome & Announcements	**3 min**

- Introductions
- Announcements

Project Updates	**5 min**

- Meeting Notes
- Public Engagement, Draft Risk Assessment

Risk Assessment – *General*	**10 min**

- Community Profile Information

Risk Assessment – *Hazard Vulnerability Assessment*	**5 min**

- Results

Mitigation Strategy	**60 min**

- Review Mission Statement
- Review Goals
- Review 2017 Actions

Next Steps	**3 min**

- February 21, 2023, 1:00–3:00 pm
- Public Engagement and Outreach
  - Draft Risk Assessment
  - Any other events?

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #5

Notes

Thursday, January 26, 2023
Time: 10:00 am - 12:00 pm

Online via Zoom

Attendance

Participants from City of Salem included Brian Carrara, Zach Diehl, Trevor Smith, Austin Ross, Anthony Gamallo, Courtney Knox Busch, and Jennifer Mongolo. DLCD staff included Cynthia Smidt. Interested community partners included Randy Navalinski, Andrew Fresh, and Juan Benavidez.

Introduction, Announcements, and Meeting Objectives

Cynthia opened the meeting at approximately 10:05 a.m. and called on participants to identify themselves as present in the Zoom meeting chat.

Cynthia announced that Greg Walsh has left the City to become Marion County's Emergency Management Director. Filling in for Greg will be Brian Carrara and Zach Diehl with Trevor Smith helping on the technology side including recording the meetings and website postings.

Cynthia reviewed the meeting objectives which included the following:

- Project Updates
- Risk Assessment- Community Profile
- Risk Assessment- Hazard Vulnerability
- Mitigation Strategy
- Next Steps

Project Updates

Meeting Minutes: The committee did not receive the meeting minutes from December 12, 2022. Review and approval of the minutes will be delayed until the February 2023 meeting.

Public Engagement Plan: Cynthia mentioned that she is continuing to work on the draft Risk Assessment section of the NHMP so it can be available for public review. It is taking her longer than anticipated and so it will be delayed until approximately February. She will work with Trevor on getting that posted.

Risk Assessment: *General*

Community Profile: Regarding *critical facilities and physical infrastructure*, Greg and Daniel Brown were going to look over the 2017 Salem NHMP list and 2022 DOGAMI list; however, this was not completed prior to Greg's departure. Brian Carrara volunteered to look over the lists and get back to Cynthia. Cynthia will send the information to Brian for review.

Zach Diehl is continuing to work on obtaining the NFIP data discussed at a previous meeting.

1

Risk Assessment: *Hazard Vulnerability Assessment*

Cynthia provided the results and ranking of the committee's Hazard Vulnerability Assessment. Cynthia explained that there was no defined way of breaking out these rankings except that there was a natural break in the totals between each category. The ranking system can help with mitigation action focus.

The committee also compared the ranking system with the 2017 NHMP hazard rankings and discussed the changes in some of the hazards. Discussion included review of how the ranking of Windstorm dropped while Winter Storm rose in rank. Randy pointed out that windstorm greatly influences other hazards such as wildfire, air quality, and winter storms. Austin reflected on the idea that windstorms are more of an amplifier of other hazards then as an isolated hazard. The committee discussed the rank drop of Flood Hazard. Jennifer pointed out that the ranking makes sense given amount of mitigation work conducted for flood hazards in the city.

The committee ultimately agree with the rating system. The following is the committee's ratings for the reviewed hazards (factor weights are applied here) and Cynthia's ranking system:

City of Salem
2022/2023 Natural Hazard Vulnerability Assessment
Based on the OEM methodology combining factors of History, Probability, Vulnerability and Maximum Threat to assess risk. Further information upon request.

HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			RISK SCORE
Extreme Heat	2 x	10	20	7 x	10	70	5 x	10	50	10 x	10	100	240
Air Quality	2 x	9	18	7 x	10	70	5 x	9	45	10 x	10	100	233
Winter Storm	2 x	9	18	7 x	10	70	5 x	9	45	10 x	10	100	233
Earthquake	2 x	3	6	7 x	9	63	5 x	8	40	10 x	10	100	209
Flood	2 x	10	20	7 x	10	70	5 x	5	25	10 x	9	90	205
Wildfire	2 x	9	18	7 x	10	70	5 x	5	25	10 x	9	90	203
Water Emergency	2 x	6	12	7 x	9	63	5 x	7	35	10 x	9	90	200
Drought	2 x	4	8	7 x	9	63	5 x	5	25	10 x	9	90	186
Windstorm	2 x	8	16	7 x	8	56	5 x	4	20	10 x	9	90	182
Landslide	2 x	8	16	7 x	9	63	5 x	2	10	10 x	4	40	129
Volcano	2 x	2	4	7 x	2	14	5 x	2	10	10 x	10	100	128

Completed by the City of Salem NHMP update Steering Committee during meetings held on November 15, 2022 and December 14, 2022

Mitigation Strategy

Mission statement: The committee reviewed the mission statement from of the 2017 NHMP and decided that it would be a good idea to revise the statement. It was discussed about marrying it up with Salem mission statements. Courtney Knox Busch was interested in a possible intersection of Salem's Climate Action Plan and the commitment with undoing the inequitable impact and "Our Salem." Austin agreed that broadening the mission statement to the larger community. Courtney referred to the city's vision, mission, and how there is a focus on community preparedness and resiliency, which is something to consider.

Courtney posted the following information in the meeting chat:

Equity in Climate Action.

2

The effects of climate change will not be borne equally by Salem residents. People who live in floodplains, who live with medical conditions, who are unsheltered or live in poverty, and/or who have limited financial and social resources to recover from extreme weather events will have the most difficulty adapting to climate impacts. Many Climate Action strategies, which address systems and practices that have historically disadvantaged groups of Salem residents, apply to other facets of City governance and community equity. Examples include:

- *Improve safe mobility and increase transportation choice in low-income neighborhoods.*
- *Engage residents in low-income neighborhoods during planning and decision-making phases to better understand the needs and priorities of specific areas in Salem.*
- *Ensure the transition to renewable energy generation and changes to waste disposal practices do not disproportionately affect low-income individuals, households, or historically marginalized commu…*

Austin provided the following information from the Salem Comprehensive Plan:

Equity means all residents have the opportunity to participate and thrive in an inclusive society. This requires rectifying unequal access to resources and opportunities caused by historic and current systems of oppression and exclusion related to race, income, ability, gender, sexual identity, and other factors. An equitable community overcomes disparities by providing increased levels of support to community members based on their needs. In Salem, it is a priority to advance equity in decision-making processes and the outcomes of those processes, including policies, investments, practices, and procedures.

Cynthia will send the Mitigation Strategy to Courtney. Courtney will review all documents discussed at this meeting, devise a draft mission statement and then will circulate the draft mission statement with Salem staff who are on the committee. A draft mission statement will return to the group at the February meeting.

Goals: Like the mission statement revision, the committee will review in mor detail. Courtney and Austin will coordinate with other Salem staff and look at all plans collectively and then will bring something back to the group. NHMP Goals will be revised during the February meeting.

Actions: The committee reviewed all the 2017 NHMP mitigation actions. A summary of the discussion regarding the status of the actions is attached. Some actions need additional research and are noted as such.

Grants, Programs and Resources:

Cynthia briefly mentioned the following programs and resources.

FEMA (https://www.fema.gov/grants)

- Safeguarding Tomorrow Revolving Loan Fund Program, Apply Feb. 1 – April 28, 2023
- Alert and Warning Technical Assistance Workshop, Webinar Feb. 14, 21 – 22
- Youth Preparedness Council (Grades 8 – 11), Apply Mar. 6

Oregon State Fire Marshall

- Community Wildfire Risk Reduction Grant, Webinar Jan. 31

Cascadia Region Earthquake Workgroup (CREW)

- Equitable Access to Affordable Earthquake Insurance, Webinar Feb. 8

Next Steps

The next meeting is set for February 21, 2023.

The meeting adjourned at 11:20 a.m.

Attachments:

1. Zoom Chat
2. 2017 NHMP mitigation action review
3. PowerPoint presentation

4

Meeting #6

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #6

AGENDA

Thursday, February 21, 2023

Time: 1:00 p.m. – 3:00 p.m.

Meeting ID: 878 6232 2099| Passcode: EgRMTc0

https://us02web.zoom.us/j/87862322099?pwd=bDk3cHVGdW13MGNzWENBbmtmQko3QT09

One tap mobile

+12532158782,,87862322099#,,,,*1550305# US (Tacoma)

+13462487799,,87862322099#,,,,*1550305# US (Houston)

Welcome & Announcements	**3 min**
• Introductions	
Project Updates	**5 min**
• Meeting Notes • Public Engagement	
Mitigation Strategy	**60 min**
• Review Mission Statement • Review Goals • Review Actions	
Next Steps	**3 min**

• Doodle Poll for future meetings
• Public Engagement and Outreach
  ▪ Draft Risk Assessment
  ▪ Any other events?	

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #6

Notes

Thursday, February 21, 2023
Time: 1:00 pm - 3:00 pm

Online via Zoom

Attendance

City of Salem staff:
Austin Ross, Community Development Dept. Planner II
Brian Carrara, Salem Fire Deputy Chief of Admin. Services
Devin Doring, Salem GIS
Heather Dimke, Public Works Dept. Climate Action Plan Manager
Jennifer Mongolo, Public Works Dept. Senior Natural Resources Planner
Treven Upkes, Salem Police
Trevor Smith, Public Works Dept. Public Information Officer
Zach Diehl, Salem Development Services

DLCD staff:
Melissa Ahrens, Regional Representative
Cynthia Smidt, Natural Hazards Planner

Community Partners:
Bill Garyfallou (MAJ Vasilios Garyfallou), Oregon Joint Operation Center
Greg Walsh, Marion County Emergency Manager, Director
Lëvy Herrera-López, Mano A Mano
Randy Navalinski, Cherriots Transportation Emergency Manager
Scott McClure, Turner City Administrator

Introduction, Announcements, and Meeting Objectives

Cynthia opened the meeting at approximately 1:05 p.m. and called on participants to identify themselves as present in the Zoom meeting chat.

Cynthia reviewed the meeting objectives which included the following:

- Project Updates
- Mitigation Strategy
- Next Steps

Project Updates

Meeting Minutes: Brian moved to approve the notes from the December 12, 2022 and January 26, 2023 meetings. Zach seconded the motion. The committee approved the notes for both meetings.

Mitigation Strategy

At the January 26 meeting, the steering committee decided to revise the mission statement and goals from what was included with the 2017 NHMP. They established a subcommittee to review and modify the statement and goals. The steering committee reviewed those changes here and made some minor modifications to the new Goal 5 and 7.

MISSION STATEMENT:

2017 NHMP	2023 NHMP
Reduce or eliminate long-term risk to people and their property from hazards and their effects.	*Identify and minimize risks and impacts to our community from natural hazards.*

Brian mentioned that the subcommittee wanted to be more inclusive with the mission statement and to not have it be directed at one group of people (for example, homeowners may be perceived through the language "people and their property" which would exclude renters in the community).

GOALS:

2017 NHMP	2023 NHMP
Goal 1: Develop and implement mitigation activities to protect human life.	*Goal 1: Develop and implement mitigation activities to protect human life in the context of a climate-altered future.*
Goal 2: Protect existing buildings and infrastructure as well as future development from the impacts of natural hazards.	*Goal 2: Strive to protect existing buildings and infrastructure from the impacts of natural hazards.*
Goal 3: Strengthen communication and coordination of public and private partnerships and emergency services among local, county and regional governments and the private sector.	*Goal 3: Develop and implement strategies and policies to promote more resilient future development, infrastructure, and systems.*
Goal 4: Enhance economic resilience to reduce the impact on the local economy.	*Goal 4: Strengthen communication, plan, practice, and coordinate emergency services among local, county, and regional governments and the private sector.*
Goal 5: Preserve and rehabilitate natural systems to serve natural hazard mitigation functions and protect natural resources.	*Goal 5: Enhance community resilience, including economic continuity and recovery, to reduce the impacts of natural hazards and promote efficient and effective recovery.*
	Goal 6: Preserve and rehabilitate natural systems to serve natural hazard mitigation functions and protect natural resources.
	Goal 7: Develop programs to promote social resilience within the community recognizing that our most vulnerable communities are often those who have been historically underserved and marginalized, especially among those most vulnerable to natural hazards.

Overall, the steering committee liked the changed goals. Additional dialogue regarding the goals are as follows:

Goals 1 – 3: Austin mentioned that the subcommittee wanted to acknowledge that to fully protect all buildings was likely not possible and that some things are out of our control. Therefore, they changed Goal 2 to include "Strive". This will allow the committee to focus on being more resilient in those things we cannot completely mitigate. Brian also noted that throughout the goals, there is an emphasis on "resilience" and to encourage community resilience, not just city resilience (the city cannot be relied upon to do everything)

Goals 4 – 6: Treven expressed concern about the removal of the work "economy" from [proposed] Goal 5. The subcommittee was trying to broaden the scope of this goal, incorporating "economy" in with "community" instead of calling it out separately. After much dialogue, the committee was satisfied with adding the phrase "including economic continuity and recovery" to the Goal 5 language.

Goals 7: Austin mentioned that the subcommittee's motivation to add this goal was to ensure that we were considering equity and their outcomes in the way we implement this plan and how it is developed. The committee agreed to a minor edit on language of the goal.

<u>ACTIONS</u>:

The committee started brainstorming mitigation actions. The committee needed more information and time to think about potential mitigation actions. Following the meeting, Cynthia will send the committee more information along with a form that can be used when receiving possible actions.

During the conversation, the following various comments and suggested mitigation actions where discussed.

Air Quality: Personal protection equipment. Have PPE more readily available. Work with retailers (sell for less or make more available for community members). Note: This action was suggested at a previous meeting by Austin, but Cynthia included it in this meetings presentation as a starting point for discussion.

Multi-hazard: Austin mentioned the idea of establishing "resiliency hubs" within the community where community members can find hazard information, training, and/or shelter prior to and/or during a hazard event. It could act as a cooling center during an extreme heat event, warming center during a winter storm, or a respite center during a poor air quality event. This will create community capacity which will get at resiliency. Heather mentioned that this action is also called out in the Salem's Climate Action Plan. Cynthia indicated that we could use mitigation actions from other plans such as the Climate Action Plan.

Austin also presented the idea of mitigation vs. adaptation and whether our goal is to create infrastructure to lessen the affects to the community, or do we make changes to adapt to new realities. Regarding the revised Goal 1, "Develop and implement mitigation activities to protect human life in the context of a <u>climate-altered future</u>", Austin asks, "do we want to look at changes to what we do now within that context?"

Treven made the following simple suggestions.

Wildfire: Set up boundaries or encourage brush clearing. More education.
Windstorms: Suggest appropriate trees and vegetation that might hold up better to windstorms. Also, if not done now, encourage the community to keep trees trimmed.
Water Quality: Require water filtration systems in new builds.

Multi-hazard: Lëvy discussed emergency preparedness and ability to be consistent across the community especially when the message will be in the language native to that community. He finds this to be a challenge. Although, there will be individuals who will be able to help, Lëvy indicates that the larger

3

community will need some level of support and "to do it consistently so it becomes a culture of emergency preparedness." This will take a lot of work and resources.

Treven suggested that Lëvy's idea could be something like an Emergency Preparedness Plan with culturally competent outreach.

Brian and Randy both inquired about the scope of these mitigation actions and whether we are looking at pre or post hazard events. Cynthia emphasized that the NHMP is renewed every 5 years so actions can be revisited. More importantly, this plan is for the city and community. If there is something that might need funding through FEMA, for example, then this plan will help.

Brian mentioned that if we had a way for the public to mitigate, we should limit it to a certain amount since there is only so much the city can do. Also in consideration is the capabilities of the city.

Multi-hazard: Austin suggested the creation of a handbook specific to Salem, Natural Hazards Ready, similar to 2 Weeks Ready. He said that that kind of outreach builds the individual resiliency and preparedness but within the scope of this plan, city will need to be willing to do or has the capacity to take on so we can work towards accomplishing them. If we cannot control the outcome, I don't know if it is within the scope of this plan.

Greg mentioned that as the former Salem EM, he spent time out in the community, trying to get people engaged, and only captured part of the population. He believes that Salem should continue doing this preparedness but is hard to set a metric. Now there is a lot of resources that is shared (churches, groups, organizations) to spread the word, it helps but it is hard to say how effective it is or was.

Cynthia suggested having a partnership with community groups, getting the message out there, so the burden is not entirely on the Emergency Manager, although the Emergency Manager would play a key role.

Lëvy indicated that partnerships are important. This might be especially true with newcomer communities since they are still learning about the resources that connect them to the community. He believes it will be more effective if you are collaborating with a trusted partner who is already connected to those communities. There would be several levels of partnerships, depending on the task or need. In past experience, however, there have been some issues that would need to be resolved. It will take a lot of collaboration from organizations. Funding would also be needed. Media will be important.

Keeping from melding mitigation and preparedness, Treven suggested establishing an overarching goal to establish a Community Preparedness Program for such outreach. That would provide an avenue for potential funding sources. Then, for this NHMP, look at the largest threats and determine what the city does now and then what we need to do to mitigate the problems.

Next Steps

A doodle poll will be sent out to determine the next meeting dates.
The meeting adjourned at 2:15 p.m.

Attachments:

1. Zoom Chat
2. 2017 NHMP mitigation action review
3. PowerPoint presentation

4

Meeting #7

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #7

AGENDA

Wednesday, April 19, 2023

Time: 1:00 p.m. – 3:00 p.m.

Meeting ID: 878 6232 2099| Passcode: EgRMTc0

https://us02web.zoom.us/j/84242165526?pwd=WE91V0JHbnduQlFpR0lxcWk1b3NiZz09

One tap mobile

+12532158782,,84242165526#,,,,*4418201# US (Tacoma)

Welcome & Announcements	**3 min**
• Introductions	
Project Updates	**10 min**
• Project Schedule update • Meeting Notes • Public Engagement	
Critical Facilities	**15 min**
• Revised List	
Mitigation Strategy	**60 min**
• Mitigation Action development • Funding requirements for mitigation projects • Mitigation Action discussion	
Next Steps	**3 min**
• Doodle Poll for future meetings • Mitigation Strategy (continued)	

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #7

Notes

Wednesday, April 19, 2023
Time: 1:00 pm - 3:00 pm

Online via Zoom

Attendance

City of Salem staff:
Anthony Gamallo, Senior Transportation Planner/Traffic Eng.
Austin Ross, Community Development Dept. Planner II
Brian Carrara, Salem Fire Deputy Chief of Admin. Services
Devin Doring, Salem GIS
Heather Dimke, Public Works Dept. Climate Action Plan Manager
Mark Bectel, Public Works Operations Manager
Trevor Smith, Public Works Dept. Public Information Officer

DLCD staff:
Melissa Ahrens, Regional Representative
Cynthia Smidt, Natural Hazards Planner

Community Partners:
Brandin Hilbrandt, North Santiam Watershed Council
Corey Fisher, Portland General Electric

Introduction, Announcements, and Meeting Objectives

Cynthia opened the meeting at approximately 1:03 p.m. and called on participants to identify themselves as present in the Zoom meeting chat.

Cynthia reviewed the meeting objectives which included the following:

- Introduction
- Project Updates
- Risk Assessment
- Mitigation Strategy
- Next Steps

Project Updates

Project Schedule: Cynthia gave an update on the project schedule. Instead of submitting the draft NHMP to OEM in June, the projected date will be in late July or early August.

Meeting Minutes: Brian moved to approve the notes from the February 21, 2023 meeting. Austin seconded the motion. The committee approved the notes for the meeting.

1

Community Engagement: Cynthia informed the committee that the draft Risk Assessment is online along with a 2-page flyer. Trevor is getting the flyer translated and will be posted soon. Once the translated flyer is available, Trevor or Brian will send out a social media post. Trevor and/or Brian will also pitch the topic to the media to see if it will be something they want to report on. Cynthia requested that the steering committee review the version in Box. Edits should be made using track changes and then uploaded back to Box. Comments or edits should be made by May 12 so we can discuss them at the next meeting.

Risk Assessment

Critical Facilities: The committee reviewed the draft critical facilities list that Brian put together. The critical facilities list was expanded and includes approximately 300 entries. The list is also located in the draft Risk Assessment. Randy made the following comments via email, which Cynthia shared at the meeting:

> ***Regarding the Salem Critical Facilities list, I did not see the Marion County Administration Bldg., 555 Court St. NE. I'm not sure if that is a building that needs to be listed but I would like to ask the question? This facility houses the county commissioner's offices, the district attorney's office, the county clerk, elections, human resources and more. It also houses the administration offices and customer service lobby for local transit, Salem Are Mass Transit District - Cherriots. The parking structure under this building is listed but I did not see the building itself, but I could have missed it.***

Brian consulted his team (Dean) regarding this building, and it will be corrected or fixed on the list. The issue is that the list is derived from a contacts list.

Cynthia suggested putting major Salem grocery stores (e.g., Fred Meyer, Safeway, Costco) on the list but wanted to hear what others thought about the idea. Austin thought it was a reasonable entity to consider. Brian was going to consult the others (Dean) on his team about adding this idea.

Heather wanted to make sure the Salem housing authority properties were on the list. Cynthia confirmed one was listed but the discussion was whether all (approx. 3-4) affordable housing projects in town should be listed. At this time, there is not a list compiled of the facilities located in Salem.

Mitigation Strategy

Capability Assessment: Mitigation requires capabilities necessary to reduce loss of life and property by lessening the impacts of disasters. With this information, Cynthia provided a high-level overview of the type of capabilities and how they can be grouped or described.

Actions: Cynthia discussed the development of problem statements to develop SMART (Specific, Measurable, Actionable, Realistic and Time Sensitive) mitigation actions that would be fundable by FEMA HMA grant programs. Working outward from existing capacity and focusing on a few priority actions were points that Cynthia made during this agenda item topic. Cynthia identified several key areas of authority FEMA expects jurisdictions or special districts to utilize including those of the Emergency Management staff, Public Works and infrastructure authorities as well as Planning and growth management authorities within development code.

Heather provided two actions that could carry over from the Salem Climate Action Plan, which are noted below. She also mentioned that there could be others pulled from the plan but because it is a 30-year plan, they are still figuring out the details of each one and how they will get implemented.

- CM07 – Create a network of neighborhood resilience hubs, indoor gathering places that can function as community centers, cooling centers, food distribution, places to access electricity during power outages, evacuation sites, day cares and community learning centers.
- CM06 – Engage faith communities, social service agencies, nonprofits and neighborhood associations in building neighborhood resilience.

Anthony discussed the following two actions related to transportation.

- Identify, map, and periodically revisit network of critical routes. Identify street segments prone to flooding. Consider bridge age and condition within critical routes.
- Analyze how historical inequities may make certain populations more vulnerable to inadequate transportation options in the event of an emergency. Incorporate best practices into emergency plans to ensure all users have adequate transportation options in emergency contexts.

Austin mentioned Salem's recent bond that includes funding for a seismic upgrade of City Hall and asked whether this is a project that could be added as a mitigation action. Cynthia indicated that some aspects of the project could be eligible for funding if the project managers want to pursue it. If that is the case, we would want to list it as a mitigation action.

Cynthia mentioned that there are several actions from other Salem-related plans that could be carried over to the NHMP. She has put some of those on her main list. She will refine her list and add the ones recommended by the group. She will share the revised list to the committee later but in the meantime, she requests that the committee continue to consider other mitigation actions.

Next Steps

A doodle poll will be sent out to determine the next meeting dates for May, June, and July.
The meeting adjourned at 2:15 p.m.

Attachments:

1. Critical Facilities list (draft)
2. PowerPoint presentation

Meeting #8

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #8

AGENDA

Wednesday, May 31, 2023

Time: 1:30 p.m. – 3:30 p.m.

Meeting ID: 854 6809 4666| Passcode: EgRMTc0

https://us02web.zoom.us/j/85468094666

Welcome & Announcements	**3 min**
• Introductions	
Project Updates	**5 min**
• Meeting Notes • Public Engagement: Risk Assessment & Mitigation Strategy	
Mitigation Strategy	**75 min**
• Action Review • Action Prioritization	
Next Steps	**3 min**
• June 26, 2023, 1:30-3:30 PM • Plan Implementation	

City of Salem NHMP, May 2023

Mission Statement: *Identify and minimize risks and impacts to our community from natural hazards.*

Goals: The plan goals describe the overall direction that the participating jurisdiction's agencies, organizations, and citizens can take toward mitigating risk from natural hazards.

Goal 1: Develop and implement mitigation activities to protect human life in the context of a climate-altered future.

Goal 2: Strive to protect existing buildings and infrastructure from the impacts of natural hazards.

Goal 3: Develop and implement strategies and policies to promote more resilient future development, infrastructure, and systems.

Goal 4: Strengthen communication, plan, practice, and coordinate emergency services among local, county, and regional governments and the private sector.

Goal 5: Enhance community resilience, including economic continuity and recovery, to reduce the impacts of natural hazards and promote efficient and effective recovery.

Goal 6: Preserve and rehabilitate natural systems to serve natural hazard mitigation functions and protect natural resources.

Goal 7: Develop programs to promote social resilience within the community recognizing that our most vulnerable communities are often those who have been historically underserved and marginalized, especially among those most vulnerable to natural hazards.

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #8

Notes

Wednesday, May 31, 2023
Time: 1:30 pm - 3:30 pm

Online via Zoom

Attendance

City of Salem staff:
Anthony Gamallo, Senior Transportation Planner/Traffic Eng.
Austin Ross, Community Development Dept. Planner II
Brian Carrara, Salem Fire Deputy Chief of Admin. Services
Heather Dimke, Public Works Dept. Climate Action Plan Manager
Trevor Smith, Public Works Dept. Public Information Officer
Zach Diehl, Development Services

DLCD staff:
Cynthia Smidt, Natural Hazards Planner

Community Partners:
Andrew Fresh, Willamette University
John Plechinger, Portland General Electric
Randy Navalinski, Cherriots Transportation

Introduction, Announcements, and Meeting Objectives

Cynthia opened the meeting at approximately 1:33 p.m. and reviewed the following meeting objectives:

- Introduction
- Project Updates
- Mitigation Strategy
- Plan Implementation
- Next Steps

Project Updates

Project Schedule: Cynthia gave an update on the project schedule as requested by Brian.

Meeting Minutes: Zach indicated that the month of the meeting is incorrect. Brian moved to approve the notes from the April 19, 2023 meeting with the corrected date. The committee approved the notes for the meeting.

Public Engagement: The Risk Assessment is posted online, including a flyer in Spanish. Cynthia asked about the Risk Assessment and whether a social media posted was sent out. Trevor will get that posted this week. Cynthia will work with Trevor and Brian regarding this posting and extending the comment period.

1

Cynthia noted that once we wrap up the mitigation action prioritization today, she will finish the mitigation strategy section so we can get it posted online for public review.

Mitigation Strategy: Actions

The Steering Committee reviewed and prioritized the mitigation actions. Cynthia provided the following considerations for action prioritization:

- 2023 NHMP Goals: Based prioritization on the new NHMP goals.
- Hazard Vulnerability Assessment: Based on HVA results
- Ease of implementation: Based on the ability to initiate and/or maintain interest in the planning process, particularly if support is tentative.
- Multi-objective actions: Based on how some actions may work toward achieving multiple community goals.
- Time: Based on how quickly actions can be accomplished vs. actions that may take longer to obtain necessary approvals or funding
- Post-disaster mitigation: The extent of damages, political will, and access to state and federal mitigation funds can dramatically alter the feasibility of implementation in a post-disaster scenario.

Cynthia also discussed a variety of ways to rank the mitigation actions. Ultimately, the Steering Committee decided to stay with the two-tiered ranking system that was established in the 2017 Salem NHMP, which included the following:

- Priority Actions: Due to resource constraints, Salem is listing a set of high priority actions to focus attention on an achievable set of high leverage activities over the next five years.
- Action Item Pool: A list of lower priority mitigation actions. Most of these actions are carried forward from prior versions of this plan. This expanded list of actions is available for local consideration as resources, capacity, technical expertise, and/or political will become available.

The steering committee made some additional edits to some of the action titles and timeframes. The action prioritization is attached to the meeting notes.

Plan Implementation: Grants

Cynthia went over the grants that require a current FEMA-approved NHMP. The following is a list of those grants along with some basic information provided to the group.

- Hazard Mitigation Grant Program (HMGP)
  - This grant funding is available after a presidentially declared disaster.
  - Provides funding to state, local, tribal and territorial governments so they can develop hazard mitigation plans and rebuild in a way that reduces, or mitigates, future disaster losses in their communities.
- Building Resilient Infrastructure and Communities (BRIC) Grant Program
  - This will support states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards.
  - The program gives states, local communities, tribes and territories funding to address future risks of natural disasters.
- Fire Management Assistance (FMA) Grant Program
  - The grant is available to states, local and tribal governments, for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands, which threaten such destruction as would constitute a major disaster.

- Rehabilitation of High Hazard Potential Dam (RHHPD) Grant Program or Dam Safety
    - 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.
    - Provides technical, planning, design, and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams.
- Public Assistance (PA) Grant Program
    - This grant funding is available after declared emergencies and major disasters
    - The program provides supplemental grants to state, tribal, territorial, and local governments, and certain types of private non-profits so communities can quickly respond to and recover from major disasters or emergencies.
- Safeguarding Tomorrow Revolving Loan Fund (STORM) Program
    - Low interest loans
    - The program 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.

Next Steps

The next meeting is June 26, 2023.

Attachments:

1. Mitigation Action prioritization list
2. PowerPoint presentation

Meeting #9

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #9

AGENDA

Monday, June 26, 2023

Time: 1:30 p.m. – 3:30 p.m.

Online via Zoom

https://us02web.zoom.us/j/87401137171

Welcome & Announcements	**3 min**
• Introductions	
Project Updates	**5 min**
• Meeting Notes	
Public Engagement	**30 min**
• Comment Review & Response	
Plan Maintenance	**20 min**
• How to continue public participation • Method and schedule for NHMP monitoring • Process for NHMP integration	
Next Steps	**3 min**
• July 19, 2023, 1:30-3:30 PM • Draft NHMP online	

City of Salem Natural Hazard Mitigation Plan

Steering Committee Meeting #9

Notes

Monday, June 26, 2023
Time: 1:30 pm - 3:30 pm

Online via Zoom

Attendance

City of Salem staff:
Austin Ross, Community Development Dept. Planner II
Brian Carrara, Salem Fire Deputy Chief of Admin. Services
Joe Hutchinson, Salem Emergency Manager (new)

DLCD staff:
Cynthia Smidt, Natural Hazards Planner

Community Partners:
John Plechinger, Portland General Electric
Randy Navalinski, Cherriots Transportation

Introduction, Announcements, and Meeting Objectives

Cynthia opened the meeting at approximately 1:33 p.m. and reviewed the following meeting objectives:

- Introduction
- Project Updates
- Public Engagement
- Plan Maintenance
- Next Steps

Project Updates

Meeting Minutes: Brian moved to approve the notes from the May 31. Austin seconded the motion. The committee approved the notes for the meeting.

Public Engagement

Public engagement involved having the draft Risk Assessment online from April to May. This included a two-page flyer in two languages (English and Spanish). The social media post announcing the draft Risk Assessment documents did not get released at the same time. It was released on June 1. The draft Mitigation Strategy together with coinciding social media posting was online for two weeks in June, ending on June 23.

Several comments were submitted online. The Steering Committee reviewed these comments and discussed resolution. The comments and responses are attached.

1

Plan Maintenance

Prior to the meeting, Cynthia, Brian, and Joe reviewed Section 4 regarding Plan Implementation and Maintenance. The Steering Committee reviewed those changes and other elements of that section.

Next Steps

The next meeting is July 19, 2023, 1:30-3:30 p.m.

Attachments:

1. Public engagement comments and responses
2. PowerPoint presentation

Meeting #10

City of Salem Natural Hazard Mitigation Plan
Steering Committee Meeting #10
Notes

Wednesday, July 19, 2023
Time: 1:30 pm - 3:30 pm

Online via Zoom

Attendance

City of Salem staff:
Austin Ross, Community Development Dept. Planner II
Brian Carrara, Salem Fire Deputy Chief of Admin. Services
Daniel Brown, Enterprise Services, GIS Manager
Devin Doring, Public Works, GIS Supervisor
Heather Dimke, Public Works, Climate Action Plan Manager
Jennifer Mongolo, Public Works, Natural Resources Planner III
Joe Hutchinson, Salem Emergency Manager (new)
Zach Diehl, Public Works, Development Services Program Manager

DLCD staff:
Cynthia Smidt, Natural Hazards Planner

Community Partners:
John Plechinger, Portland General Electric
Randy Navalinski, Cherriots Transportation

Introduction.

Cynthia opened the meeting at approximately 1:32 p.m. An agenda was not provided prior to the meeting.

Project Updates

Meeting Minutes: Brian moved to approve the notes from June 26. Austin seconded the motion. The committee approved the notes for the meeting.

Brian noted that he contacted the commenters.

NHMP Draft Review

Cynthia is wrapping up the NHMP. She is uploading documents to BOX for review and requested the committee review, at the least, Appendix C, Community Profile. Cynthia mentioned she moved one section from Risk Assessment into Mitigation Strategy and requested Brian review it. Cynthia thanked everyone for participating in the NHMP process. She also noted that if OEM or FEMA requests changes that warrant the committee to reconvene, Brian and Joe will let you know. Otherwise, changes will be worked out between her and Brian and Joe.

Next Steps

Cynthia plans to submit the final NHMP to OEM by the end of the day, July 31.
Meeting adjourned at 1:45 p.m.

1

Salem NHMP Webpage

CITY OF Salem AT YOUR SERVICE

Payments Jobs City Directory Select Language What are you looking for?

Community Business Government I Want To...

EMERGENCIES & DISASTER PREPAREDNESS

- Current Road Conditions (Map)
- View Traffic Cameras
- Flooding
- Get Community Alerts
- Get Sandbags (Map)
- Get #2WeeksReady Challenge
- Reduce Your Home's Risk of Earthquake Damage
- Salem Area Rainfall
- Salem Weather
- Natural Hazard Mitigation Plan Update

Natural Hazards Mitigation Plan (2017)

Salem_NHMP_FEMA_Review_Tool_APA_11-6-17

2022-09-06_R4_Salem_NHMP_Update_Focus

Community » Safety » Emergencies & Disaster Preparedness »

Natural Hazard Mitigation Plan Update 2022/23

This site is designed to provide a landing page for the 2022/2023 update to the Natural Hazard Mitigation Plan (NHMP) for the City of Salem.

According to 44CFR 201.6 - Local Mitigation Plans, the City must update their plan every 5 years. More requirements and details as to the regulation for Local Mitigation Plans can be found here 44 CFR 201.6

The last update for the City of Salem NHMP was completed and signed in January of 2018. And was a collaborative effort with University of Oregon Emergency Extension.

This plan is being updated in collaboration of the Oregon Department of Land Conservation and Development (DLCD) plan writers as part of a shared effort.

What is the Natural Hazard Mitigation Plan?

City of Salem is updating this Natural Hazards Mitigation Plan (NHMP) in an effort to prepare for the long-term effects resulting from natural hazards. It is impossible to predict exactly when these 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, and citizens within the community, it is possible to create a resilient community that will benefit from long-term recovery planning efforts.

Why Develop this Mitigation Plan?

In addition to establishing a comprehensive community-level mitigation strategy, the Disaster Mitigation Act of 2000 (DMA2K) and the regulations contained in 44 CFR 201 require that jurisdictions maintain an approved Natural Hazard Mitigation Plan (NHMP) in order to receive federal funds for mitigation projects. Local and federal approval of this Plan ensures that the city will remain eligible for pre- and post-disaster mitigation project grants.

Partners involved in the 2022/23 update:

The City of Salem NHMP is the result of a collaborative effort between the city, special districts, citizens, public agencies, non-profit organizations, the private sector and regional organizations. The city's steering committee guided the plan development process.

Participants in the plan update will be listed in the next update to our page.

The Salem Emergency Manager convened the planning process and will take the lead in implementing, maintaining, and updating the plan. Salem is dedicated to directly involving the public in the continual review and update of the natural hazards mitigation plan. Although members of the Steering Committee represent the public to some extent, the public will also have the opportunity to continue to provide feedback about the plan throughout the implementation and maintenance period

The Way Forward

The first meeting of the NHMP Update will be held on September 29th 2022. Following that an update will be provided including a recording for public viewing.

In the near future the plan will be open for public comment, a system of signing up to be included will be provided in the near future.

Please check back on this site for continued updates.

NHMP Kickoff Meeting

This is the video from the first meeting on the Natural Hazard Mitigation Plan update

https://youtu.be/h_YuVkVADcQ

NHMP Kickoff Meeting

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NHMP Meetings

October Meeting Wednesday 10/19/2022 at 1:00 PM https://youtu.be/YTDyToLtJSk

November Meeting Tuesday 11/15/2022 at 1:00 PM https://youtu.be/Df5zM8B3Xtc

December Meeting Wednesday 12/14/2022 at 09:00 AM https://youtu.be/3yCT48UldNk

January Meeting Thursday 1/26/2023 at 10:00 AM https://youtube.com/live/Wt3lGRRA9iE

February Meeting Tuesday 2/21/2023 at 1:00 PM https://youtube.com/live/0uyB1ceXBdE

April Meeting Wednesday 4/19/2023 at 1:00 PM https://youtu.be/LBh3kk_dhSQ

May Meeting Wednesday 5/31/2023 at 1:30 PM https://youtube.com/live/9w1RWH4ETdQ

June Meeting Monday 5/26/2023 at 1:30 PM

Salem NHMP Webpage (part) & Social Media for Draft Risk Assessment

Salem weather

Natural Hazard Mitigation Plan Update

Wildfire Mitigation and Preparedness

Risk Assessment Information

Risk Assessment Spanish

2023 Draft Risk Assessment

Comment on the Plan

Natural Hazards Mitigation Plan (2017)

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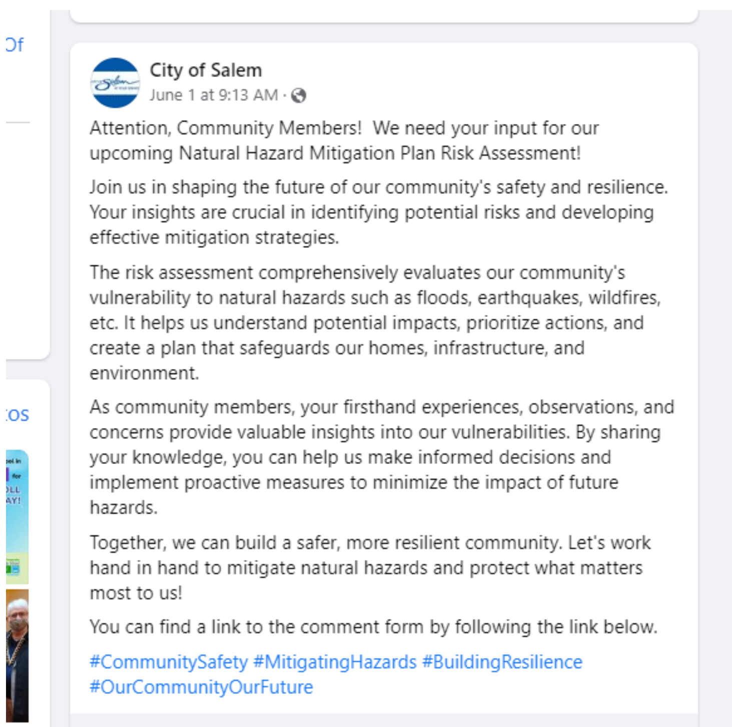

City of Salem

June 1 at 9:13 AM ·

Attention, Community Members! We need your input for our upcoming Natural Hazard Mitigation Plan Risk Assessment!

Join us in shaping the future of our community's safety and resilience. Your insights are crucial in identifying potential risks and developing effective mitigation strategies.

The risk assessment comprehensively evaluates our community's vulnerability to natural hazards such as floods, earthquakes, wildfires, etc. It helps us understand potential impacts, prioritize actions, and create a plan that safeguards our homes, infrastructure, and environment.

As community members, your firsthand experiences, observations, and concerns provide valuable insights into our vulnerabilities. By sharing your knowledge, you can help us make informed decisions and implement proactive measures to minimize the impact of future hazards.

Together, we can build a safer, more resilient community. Let's work hand in hand to mitigate natural hazards and protect what matters most to us!

You can find a link to the comment form by following the link below.

#CommunitySafety #MitigatingHazards #BuildingResilience #OurCommunityOurFuture

Salem NHMP Website (part) & Social Media for Draft Mitigation Strategy

Risk Assessment Information

Risk Assessment Spanish

2023 Draft Mitigation Strategy

Comment on the Plan

[Natural Hazards Mitigation Plan (2017)]

What is the Natural Hazard Mitigation Plan?

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Partners involved in the 2022/23 update:

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City of Salem
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Salem is seeking input on the 2023 Natural Hazards Mitigation Plan.

The plan establishes a strategy for reducing risk from natural hazards. Some of the details considered in this plan are how to protect human life in the context of environmental change, how to protect property and infrastructure, plans to promote resiliency, strengthening communications, promoting programs for vulnerable communities, and preserving natural systems and functions of our environment.

The deadline to provide comments is June 23, 2023.

Go to https://www.cityofsalem.net/.../natural-hazard-mitigation... to read the draft report and provide your comments.

photos

Salem Risk Assessment Flyer, English

City of Salem
Natural Hazards Mitigation Plan Update
April 2023

Poor Air Quality, Drought, Flood, Earthquake, Wildfire…

What Natural Hazards Concern You?

Communities are stronger when they recognize the risks from natural hazards and make efforts to reduce risk from their effects.

Natural Hazard Mitigation Plans identify risks from natural hazards and develop actions and strategies to mitigate those risks.

The current ***City of Salem Natural Hazards Mitigation Plan*** (NHMP) was completed in 2017. The City is now collaborating with the Oregon Department of Land Conservation and Development (DLCD) to update the NHMP. The updated NHMP will return the City's eligibility for disaster-related funding.

What's Happening Now?

The City of Salem Emergency Management team has convened representatives from various city departments; in addition to, community businesses and organizations to update this plan in order to increase resilience to natural hazards events in Salem.

Public Information Session: Risk Assessment

The draft Risk Assessment of the NHMP has been completed. The full version can be viewed online at [Natural Hazard Mitigation Plan Update 2022/23 | Salem, Oregon (cityofsalem.net)]

For more information contact:
Brian Carrara, City of Salem Fire Department
Deputy Chief of Administrative Services
BCARRARA@CITYOFSALEM.NET
Or
Cynthia Smidt, DLCD Natural Hazards Planner
Cynthia.Smidt@dlcd.Oregon.gov

Photos credits: Flooding in City of Salem, Oregon 1996 by unknown; Vitae Springs Wildfire in September 2022 by Salem Fire Department

City of Salem's Natural Hazards

- Air Quality
- Drought
- Earthquake
- Extreme Heat
- Flood
- Landslide
- Water Quality
- Windstorm
- Winter Storm
- Wildfire
- Volcano

Public Information Session: Risk Assessment

What hazards are new to the 2023 NHMP Risk Assessment? The Steering Committee agreed to add Air Quality and Water Quality to the 2023 NHMP hazards list.

What else changed in the 2023 NHMP Risk Assessment? Each of the 11 identified hazards have been updated and expanded to include more information in the following categories: causes and characteristics, location and extent, hazard event standards, history, future climate variability, probability assessment, community vulnerability, and mitigation activities and resources.

City of Salem 2022/2023 Natural Hazard Vulnerability Assessment	
HAZARD	RISK SCORE
Extreme Heat	240
Air Quality	233
Winter Storm	233
Earthquake	209
Flood	205
Wildfire	203
Water Emergency	200
Drought	186
Windstorm	182
Landslide	129
Volcano	128

Completed by the City of Salem NHMP update Steering Committee during meetings held on November 15, 2022 and December 14, 2022

Participation

As part of the Natural Hazards Mitigation Plan (NHMP) update for the City of Salem, the Steering Committee conducted an exercise based on the Oregon Office of Emergency Management and FEMA's methodology to evaluate the risk of damage and displacement from the range of natural hazards identified. The evaluation of the hazards was based on four factors: Historical Frequency, Probability, Vulnerability, and Maximum Threat. The table above is the result of that exercise. **Does it reflect your perception of the risk posed by these natural hazards?**

The Steering Committee will now turn its attention toward actions intended to reduce risk from these hazards. **Would you like to learn more?** If so, please visit the City of Salem's Emergencies & Disaster Preparedness webpage on Hazard Mitigation at this link: [Natural Hazard Mitigation Plan Update 2022/23 | Salem, Oregon (cityofsalem.net)]

Salem Risk Assessment Flyer, Spanish

Actualización del Plan de Mitigación de Peligros Naturales de la ciudad de Salem

Abril de 2023

Mala calidad del aire, sequías, inundaciones, terremotos, incendios forestales...

¿Cuál peligro natural le preocupa?

Las comunidades son más fuertes cuando reconocen los riesgos de los peligros naturales y toman medidas para reducir el riesgo de sufrir sus efectos.

Los planes de mitigación de peligros naturales identifican los riesgos de los peligros naturales y desarrollan acciones y estrategias para mitigarlos.

El ***Plan de Mitigación de Peligros Naturales*** (*Natural Hazards Mitigation Plan*, NHMP) de la ciudad de Salem se completó en 2017. La ciudad ahora colabora con el Departamento de Conservación y Desarrollo de Tierras (*Department of Land Conservation and Development*, DLCD) de Oregon para actualizar el NHMP. El NHMP actualizado hará que la ciudad vuelva a calificar para la financiación relacionada con los desastres.

¿Qué está pasando?

El equipo de manejo de emergencias de la ciudad de Salem ha nombrado representantes de varios departamentos de la ciudad, además de negocios y organizaciones de la comunidad, para actualizar este plan con el fin de aumentar la resiliencia ante los peligros naturales en Salem.

Sesión informativa pública: evaluación de riesgo

Se completó el borrador de la evaluación de riesgo del NHMP. La versión completa está disponible en línea en [Actualización del Plan de Mitigación de Peligros Naturales de 2022/2023 | Salem, Oregon (cityofsalem.net)]

Para obtener más información, comuníquese:
Brian Carrara, Departamento de Bomberos de la ciudad de Salem
Jefe adjunto de Servicios Administrativos
BCARRARA@CITYOFSALEM.NET, (503) 932-5785
O con
Cynthia Smidt, planificadora de peligros naturales del DLCD
Cynthia.Smidt@dlcd.Oregon.gov, (503) 804-0902

Créditos de las fotos: inundaciones de la ciudad de Salem, Oregon, en 1996, por desconocido; incendio forestal de Vitae Springs cerca de Salem, Oregon, en septiembre de 2022, del Departamento de Bomberos de Salem

Peligros naturales de la ciudad de Salem

- Calidad del aire
- Sequías
- Terremoto
- Calor extremo
- Inundaciones
- Corrimiento de tierra
- Calidad del agua
- Vendaval
- Tormenta de invierno
- Incendios forestales
- Volcán

Ciudad de Salem
Evaluación de vulnerabilidad ante los peligros naturales de 2022/2023

PELIGRO	PUNTAJE DE RIESGO
Calor extremo	240
Calidad del aire	233
Tormenta de invierno	233
Terremoto	209
Inundaciones	205
Incendios forestales	203
Emergencia hídrica	200
Sequías	186
Vendaval	182
Corrimiento de tierra	129
Volcán	128

Realizada por el Comité directivo de la actualización del NHMP de la ciudad de Salem durante las reuniones del 15 de noviembre de 2022 y del 14 de diciembre de 2022

Sesión informativa pública: evaluación de riesgo

¿Qué peligros son nuevos en la evaluación de riesgo del NHMP de 2023? El Comité directivo acordó agregar la calidad del aire y la calidad del agua a la lista de peligros del NHMP de 2023.

¿Qué más cambió en la evaluación de riesgo del NHMP de 2023? Se han actualizado y ampliado cada uno de los 11 peligros identificados para incluir más información en las siguientes categorías: causas y características, ubicación y alcance, estándares del peligro, historia, futura variabilidad del clima, evaluación de probabilidad, vulnerabilidad de la comunidad y actividades y recursos de mitigación.

Participación

Como parte de la actualización del Plan de Mitigación de Peligros Naturales (NHMP) para la ciudad de Salem, el Comité directivo llevó a cabo una actividad en función de la metodología de la Oficina de Manejo de Emergencias de Oregon y la Agencia Federal para el Manejo de Emergencias (*Federal Emergency Management Agency*, FEMA) para evaluar el riesgo de daño y desplazamiento del rango de peligros naturales identificado. La evaluación de los peligros se basó en cuatro factores: frecuencia histórica, probabilidad, vulnerabilidad y amenaza máxima. La lista que aparece arriba es el resultado de esa actividad. **¿Refleja su percepción del riesgo que suponen estos peligros naturales?**

El Comité directivo ahora se centrará en las acciones destinadas a reducir el riesgo de estos peligros. **¿Desea obtener más información?** De ser así, visite la página web sobre mitigación de peligros de Preparación para Emergencias y Desastres de la ciudad de Salem en este enlace: [Actualización del Plan de Mitigación de Peligros Naturales de 2022/2023 | Salem, Oregon (cityofsalem.net)]

Public Comments and Steering Committee Resolution

Table B-4 Draft Risk Assessment and Mitigation Strategy Public Comments

Commenter	Public Comment	Resolution
not provided	In response to the bizarre post made by the city claiming trees are a godsend to all properties (5/31/23 12:34pm) the following comment was made and liked by four others. "A mature tree does not equate to $10k in appraised value of your home." A street tree the city will not allow for removal yet that's dying, breaking your driveway, breaking your water main (twice now), filling your neighbors and your gutters with debris and covering cars in sap does not add $7k in value to your home or better the neighborhood as hazard branches drop each wind storm."	The remark was aimed at a different Facebook comment discussing trees, specifically in response to another City of Salem post about street trees. Although the comment wasn't directed at the NHMP (New Hampshire Master Plan), it's worth mentioning that the *2023 City of Salem NHMP* covers trees and their role in mitigating the impacts of certain natural hazard events.
not provided	An option for remedy for hazard trees should be the ability of a property owner and/or neighbors that agree a tree should go, should be able to remove the tree at their own cost and replant one in a safer and more suitable location and of a species that makes more sense than a huge fir directly ON TOP OF the home and neighbors primary water service lines.	The comment was initially aimed at a different Facebook comment discussing trees, specifically in response to another City of Salem post about street trees. It's important to note that the comment wasn't intended for the NHMP but for another City of Salem, Facebook post specifically focused on street trees. Nonetheless, it's worth mentioning that the *2023 City of Salem NHMP* covers trees and their role in mitigating the impacts of certain natural hazard events.
Bridget Good	Thank you for the opportunity to provide feedback! Plan States: Page 2-44, "Cascadian Subduction Zone" Suggestion: Should be "Cascadia Subduction Zone"	Any suitable modifications will be implemented in the 2023 City of Salem NHMP. The NHMP project manager has contacted the commenter to clarify any alterations resulting from suggestions 3 through 8.
Bridget Good	Plan States: Page 2-54, "The average recurrence interval of these great Cascadia earthquakes is approximately 500 years, with gaps between events as small as 200 years and as large as 1,000 years." Suggestions: These three timeframes are not up-to-date and could use clarification regarding the magnitude of earthquakes being discussed. 2016 data changed the intervals. OSU states, "A section of the zone from Newport to Astoria, Oregon, was previously believed to rupture on average about every 400-500 years, and that average has now been reduced to 350 years. A section further north from Astoria to Vancouver Island was previously believed to rupture about every 500-530 years, and that average has now been reduced to 430 years... The southern portions of the subduction zone south of Newport, Oregon, tend to rupture more frequently - an average of about every 300-380 years from Newport to Coos Bay, and 220-240 years from Coos Bay to Eureka, California." https://today.oregonstate.edu/archives/2016/aug/subduction-zone-earthquakes-oregon-washington-more-frequentprevious-estimates. When magnitudes smaller than 9.0's are considered, there has not been a 1,000-year gap in the most recent 10,000-year history. 577 would be the max. However, if only 9.0+ are being discussed, 1,190 was the longest. It's unclear which range is being discussed, so that statement could use clarification.	The suggested change will be researched and, if necessary, changed.
Bridget Good	Plan States: Page 2-57 "Future climate variability does not affect the community's earthquake risk." Suggestion: I disagree with this statement, as climate change has increased the frequency, size, and intensity of fires in the region. Fires often occur in cities when an earthquake happens, and those fires could be more formidable as a result. Also, it seems like intense storms, made more frequent and powerful by climate change, could impact soil stability for landslides and liquefaction co-hazards.	The suggestion made by the commenter lacks a factual basis. As the *2023 City of Salem NHMP* relies on the OCCRI Future Projections Report for information on this matter, it was determined that no change would be made based on this suggestion.
Bridget Good	Plan States: Page 2-58 "According to the 2020 Oregon NHMP, the return period for the largest of the CSZ earthquakes (magnitude 9.0 or greater) is 530 years with the last CSZ event occurring 314 years ago in January of 1700." Suggestions: As mentioned above, that "530" year fact has been updated to reflect new findings and should read 430. The "314 Years ago" statement should say 323 years.	The suggested change will be thoroughly researched, and if deemed necessary, it will be implemented. Nevertheless, it has been concluded that the information included in the *2023 City of Salem NHMP* falls within an acceptable range.
Bridget Good	Plan States: "The probability of a magnitude 9.0 or greater CSZ event occurring in the next 50 years ranges from 7 - 12%." Suggestion: The intervals that were updated in 2016 impacted this probability, as well. The OSU findings state, "Of the part of the zone off central and northern Oregon, the chance of an event during that period has been changed to 15-20 percent instead of 14-17 percent. On the furthest north section of the zone off Washington and British Columbia, the chance of an event has increased to 10-17 percent from 8-14 percent."	The suggested change will be thoroughly researched, and if deemed necessary, it will be implemented. Nevertheless, it has been concluded that the information included in the 2023 City of Salem NHMP falls within an acceptable range.

Commenter	Public Comment	Resolution
Bridget Good	Plan States: "The combined probability of any CSZ earthquake occurring in the next 50 years is 37 - 43%." Suggestions: The 37% is based on the log-normal formula… which has shown our probability decreasing since it "peaked" in 2017. We are on the downside of the curve, so our risk will never grow on this model. I'm not sure where the 43% is coming from. My guess is the Gaussian model, which is currently at 47% (rounded down). Until the Long-Term Fault Memory model comes out from the team at Northwestern University to possibly replace the Log Normal %, I'd recommend adding the line from the USGS paper that states, "Failure analysis suggests that by the year 2060, Cascadia will have exceeded ~27 percent of Holocene recurrence intervals for the northern margin and 85 percent of recurrence intervals for the southern margin." We have already surpassed 81% as of today. If only the most recent 6,030 years are considered, we have already surpassed 93% of recurrence intervals in the southern margin. USGS research paper Turbidite Event History—Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone (pg 2 (14/184)). Dates for earthquakes T1 through T18 can be found in Table 10 (shown here on the right), page 97, (109/184) & event 19, listed at ~10,200 cal yr B.P. can be found on page 32 (44/184) of the same paper.	This suggestion will be researched and, if necessary, will be changed if the edits are minor. The Steering Committee decided that the suggested information is more detailed then is necessary to include *2023 City of Salem NHMP* .
Susann Kaltwasser	I'm a neighborhood association chair person and this is the first I heard about this update. I recall the previous work from 2017, but not this update. NA should have been informed and offered presentations over a year ago. It takes time to understand the issues let alone be able to give meaningful comments. My neighborhood flooded in 1996 and likely will again some day CERT was ineffective. Many people had unnecessary impacts on their homes. They were not aware even that their area could flood. Also neighbors have no real awareness of the danger of a wildfire east of Cordon and how it could impact the denser areas of east Salem. Most are non-English speakers and don't use any form of social media. My guess is many don't sign up for emergency alerts. We have pockets of Russian, Ukrainian and Hispanics immigrants who neither read or speak English.	While neighborhood associations may have been regarded as stakeholders during the early stages of the NHMP process, they were not contacted for unknown reasons. The City acknowledges and values the collaborative efforts previously undertaken with neighborhood associations. Any additional suggestions will be taken into consideration during community outreach efforts. The NHMP convener has reached out to this commenter to explain.
Fraser Wick	This plan does not account for the last 2 years of level 1-2-3 wildfire evacuations for residents in South Salem. How is the city investing in mitigating risks of wildfires in [these] areas? Will the City of Salem consider adopting Wildland Urban interface building code, similar to ones adopted in California and Colorado, to protect residents?	The *2023 City of Salem NHMP* emphasizes historical hazard events that have impacted the City and its surrounding region. Furthermore, during the 2021 Oregon legislative session, Senate Bill 762 (SB 762) on Wildfire Adapted Communities was enacted. SB 762 incorporates provisions mandating new constructions to adhere to enhanced building code standards that address wildfire hazards in similarly vulnerable areas. The NHMP convener has reached out to this commenter to explain.
Michael Pfenning via Facebook Confirmed by Samuel Welling, Daryn Jones, Nana Klein, Patrick Stevens	Doesn't matter what input there is, you'll do whatever you want.	No action taken.
Marc Olson via Facebook	Electric power wires,exposed Electric lines using poles high voltage threw trees. Electric service designed in 1945. Ice storms, power outage., now Electric cars.???	Portland General Electric looked into this concern.
Elizabeth Underwood via Facebook	You mean like putting some type of drainage on the bridges so the roads don't flood everytime it rains 🙄 one would have thought that would have been addressed at the very least on the bridge was shut down for months last summer.	Comment passed onto Salem transportation planner to incorporate into upcoming analysis.
Sally Cook	--	No action taken.

Commenter	Public Comment	Resolution
Rebecca Beaman	1. (Major) Page 2-66, Salem-Keizer Public Schools: The Plan states: "Salem-Keizer Public Schools conduct earthquake drills regularly throughout Oregon and teach students how to respond when an earthquake event occurs. This is incorrect. Salem-Keizer Public Schools conduct FIRE DRILLS regularly and pretend that they are sufficiently similar to earthquake drills. The children are NOT taught to take shelter under their desks; they are NOT warned that there will be a significant risk of hazardous broken glass from windows; they are NOT taught to move slowly to avoid further injury; they are NOT evacuated WITH their coats and lunches so that they can handle standing outside in the weather for hours. Further, the schools will lack communication to the district authorities following a Cascadia subduction zone earthquake, as they are 100% dependent on telephones (failing thus to incorporate radio comms and failing to put a district administrator adjacent to or in the Emergency Operations Center). Schools expect parents to arrive at the schools promptly to claim their children, regardless of the damage to transportation routes. Children and staff will thus be left standing outside in the weather, without coats, without tarps for protection from rain, for many hours (assuming teachers will stay with their assignments despite their own children potentially being in the same situation at other sites). They will be without toiletting facilities (even rudimentary pee and poop buckets would be an improvement), without water, without food. Mitigating steps, such as systematically encouraging parents to authorize robust lists of persons authorized to pick up their children in the event of a CSZ earthquake, have not been taken. CERT team members who have offered to connect the school official(s) to higher authorities in an emergency have been rebuffed. There is NOT an adequate plan for earthquake response in the schools, and we are fools to pretend otherwise. This report should reflect this fact.	The Salem-Keizer School District conducts semi-annual earthquake drills involving students and faculty members. It is acknowledged that most of the twelve suggestions put forth by the commenter are related to response plans and may not be directly applicable to the NHMP. Nevertheless, these suggestions offer valuable opportunities for public engagement and education. The NHMP convener has reached out to the commenter to discuss the twelve recommendations and provide an explanation regarding the committee's decision.
Rebecca Beaman	2. (Major) Page 2-66, City of Salem: This section should describe also the activities and contribution of the Community Emergency Response Team (CERT) volunteers throughout Salem. CERT provides a valuable bridge between the centralized, paid emergency responders and the citizens in the community. The City of Salem has failed to recognize the importance of CERT and has made it extremely difficult to integrate CERT into the emergency planning process. Where there are CERT cache locations across the city, there will be a source of information for the city (which roads are closed, and what they are closed by; how many homes have been rendered unusable and what are the former occupants doing for shelter; are there fires still burning and where; numbers of dead; numbers of severely wounded and where they are, the nearest helicopter landing option, etc). Where there are CERT cache locations across the city, there will be a nucleus of people who can report on the state of peoples' provisioning, and pass word to the neighborhoods when and where there will be food or water supplies made available. It seems that the City of Salem is relying on the passive "we are providing information on the internet" to pass the word, and ignoring the efforts of CERT members in the community who go door to door with information, building communities that will be more likely to survive the aftermath of a major earthquake.	A statement will be added to the relevant section of the NHMP, acknowledging that the efforts are being carried out in coordination with CERT (Community Emergency Response Team). Additionally, CERT will be included as a partnering organization under Action MH #11.
Rebecca Beaman	3. (Major) Page 2-66, City of Salem: Once we get the City to recognize what CERT Caches and CERT members can do for the City's mission in the aftermath of a megaquake, it will be time to assess the adequacy of the attention, effort and resources the city does/does not give to the program. Is this the moment where it's useful to point out that the City of Salem has failed to issue identification badges to CERT members since 2019, and there are over 200 people qualified to perform CERT duties who have no identification indicating this? When the roads are closed to fire department vehicles, how will the City reach out to the community and offer assistance?	The City of Salem Emergency Management has responded to this comment. It has been explained that, due to the impact of COVID-19, specific routine tasks such as issuing identification badges have been affected.
Rebecca Beaman	4. (Major) Page 2-68, Figure 2-22: South River Road and Madrona Ave west of Liberty St are extremely challenging transportation routes, topographically speaking. Madrona Ave is expected to fall off the steep hillside where it is etched into the slope, and it is not clear that clearing the debris and establishing a temporary route will be the best use of resources in the aftermath of a megaquake, with aftershocks. South River Road is flatter, but the hillside above it is steep and already prone to rockslides without the prompting of a megaquake. Hansen Ave, which connects to Acacia Dr to finish its downhill run, is another way to establish a transportation corridor through the area that could be reached by teams on foot coming from the neighborhoods seeking help. Please conduct a trade-off analysis to determine whether prioritizing Madrona debris removal rather than moving to a Hansen-Acacia route makes more sense in the aftermath of a CSZ megaquake.	This suggestion holds value concerning the ongoing transportation analysis mentioned in Action MH #1 of the plan.
Rebecca Beaman	5. (Major) PP 2-124 through 2-135: The section on landslides fails to address the intersection of emergency routes and landslides. There are at least two established emergency routes that cross terrain highly vulnerable to landslides (South River Road and Madrona Ave west of Liberty St). Planning in advance for significant landslide effects on these two routes would mitigate the risk that inordinate effort would be required to recover emergency capabilities following a landslide/earthquake. The City of Salem should have a pre-established alternative route for vulnerable sections and describe the process for evaluating landslide impacts and switching to "Plan B." A map similar to Figure 2-22 should be included here, with similar discussion of priorities for recovery in the event of landslides.	This suggestion holds significance in the present transportation analysis outlined in Action MH #1. It is worth considering highlighting the provided example in the NHMP.
Rebecca Beaman	6. (Admin) Add a Table of Contents to this document. It is far too long to expect people to finger through it to find an area of interest. Also, have a list of figures and a list of tables section, so we can flip easily to any given figure when discussing the document.	A Table of Contents and a list of Tables and Figures will be included in the NHMP.
Rebecca Beaman	7. (Major) Page 2-168: This section mentions natural disasters such as earthquakes as potential impediments to Salem's water supply, but fails to address risk mitigation steps to ensure the supply of water all the way into homes and businesses in the event of widespread infrastructure failure as is expected with a CSZ megaquake. I am not certain whether it belongs in this section on Water or the previous section on Earthquakes, but mitigation steps such as were taken during the algal blooms (procurement of trucks and water bladders loaded on dump trucks to establish community supply points, etc) should be addressed. Education of the citizenry on how to get potable water from hot water tanks is also essential in the days immediately following a natural disaster such as a megaquake, since it will take some time to establish transportation routes for any such water trucks.	Most of the twelve suggestions noted by the commenter are related to response plans and are not applicable to the *2023 City of Salem NHMP* . Nevertheless, the NHMP takes into account these concerns. Comments may be incorporated into the NHMP, where appropriate.

Commenter	Public Comment	Resolution
Rebecca Beaman	8. (Major) The State of Oregon has established the authority for the Governor to impound private property, such as fuel supplies, in the event of an emergency such as the CSZ megaquake. Impoundment of all gas and oil products immediately following such a quake will be essential to maintaining power at priority emergency response locations such as hospitals, police and fire services (generators, if nothing else given the impact to the transportation infrastructure). It is important that the citizenry understand such provisions in order to make realistic plans for their own CSZ megaquake response, since they are largely unprepared for electricity and natural gas being unavailable for several MONTHS at minimum.	Most of the twelve suggestions mentioned by the commenter primarily pertain to response plans, which do not directly apply to the *2023 City of Salem NHMP* . However, the NHMP acknowledges and considers these concerns. Comments that are relevant and appropriate may be incorporated into the NHMP.
Rebecca Beaman	9. (Major) This section on Wildfires fails to address the risk of wildfires originating from human activity (warming, cooking) in the aftermath of a CSZ earthquake. I am uncertain whether this belongs in this section or in the section on Earthquakes. The risk of significant damage is far greater following a megaquake, as there will not be adequate water to support firefighting activities, firefighters will be unable to get to the incident location due to transportation impacts, and the task of controlling the blaze will fall to those immediately at the site of the incident using fire extinguishers and mechanical smothering actions. Mitigation in this case would be WIDE dissemination of information emphasizing the need for fire extinguishers in the hands of the citizenry.	Most of the twelve suggestions mentioned by the commenter primarily pertain to response plans, which do not directly apply to the *2023 City of Salem NHMP* . However, the NHMP acknowledges and considers these concerns. Comments that are relevant and appropriate may be incorporated into the NHMP.
Rebecca Beaman	10. (Major) PP 2-234 through 236: The vulnerability of the water and sewer lines all the way to people's houses are not addressed in this section. The impact of inadequate (non-existent) sewer facilities in the aftermath of a CSZ megaquake cannot be overstated. This is not hyperbole -- in the absence of a flush toilet, where are people going to defecate? If we have planned and mitigated the risk, they will create millions of plastic bags of human waste that the County has no idea how to process; if we haven't reached enough of the population, they will dig trenches and defecate into the ground water. (See "You Survive the Earthquake but Die of Dysentery", Merilee D. Karr, MD presenter, available on YouTube)	Most of the twelve suggestions mentioned by the commenter primarily pertain to response plans, which do not directly apply to the *2023 City of Salem NHMP* . However, the NHMP acknowledges and considers these concerns. Comments that are relevant and appropriate may be incorporated into the NHMP.
Rebecca Beaman	11. (Major) The bulk of the risk assessment (and in particular the ratings in Table 2-21 page 2-220) focuses on the critical nodes of the city's structure, not the impact of taking out the entire network. In a CSZ megaquake, water and sewer supplies to the entire population of Salem will be disrupted for an absolute minimum of 2 weeks -- that's 188,000 people without electricity, water, sewer, natural gas, and communication -- is that really a vulnerability score of 8? You can restore all the nodes in the process that you want -- if you can't deliver the goods to the end point (the residences) you haven't accomplished much. The buildings will survive fairly well, as long as they aren't masonry. But without adequate preparation across the entire population, we will be at the sanitation level of the worst homeless camps we see every day.	The *2023 City of Salem NHMP's* primary objective is to enhance critical facilities' resilience, enabling them to withstand natural hazards. The City aims to expedite the recovery process, ultimately improving the overall community recovery. Establishing a network of neighborhood resilience hubs (Action MH #11) plays a vital role in facilitating this recovery process.
Rebecca Beaman	12. (Critical) There is no discussion in this document of a relocation of the citizenry. Planning for such relocation is critical to surviving some of these natural disasters. During the summer of the Santiam fires, it is inarguable that lives were saved ONLY by evacuation (relocation). Loves were also lost by delays in evacuation, some of which would have been avoidable had the populace been prepared for the possible necessity of evacuation. Now we keep bug-out bags if we want to be prepared, except that the majority of the population is of the "it will never happen to me" sort. Relocating the elderly and frail population out of the earthquake zone will be an important lifesaving step in mitigating the impacts of a CSZ megaquake	In particular, during an earthquake, the City cannot determine the appropriate relocation sites for citizens until a formal post-disaster evaluation is conducted to identify safe structures. In this recovery process, establishing a network of neighborhood resilience hubs (Action MH #11) plays a crucial role. These resilience hubs are integral in facilitating the community's recovery and providing safe spaces for citizens.
Haley Lehman	--	No action taken.

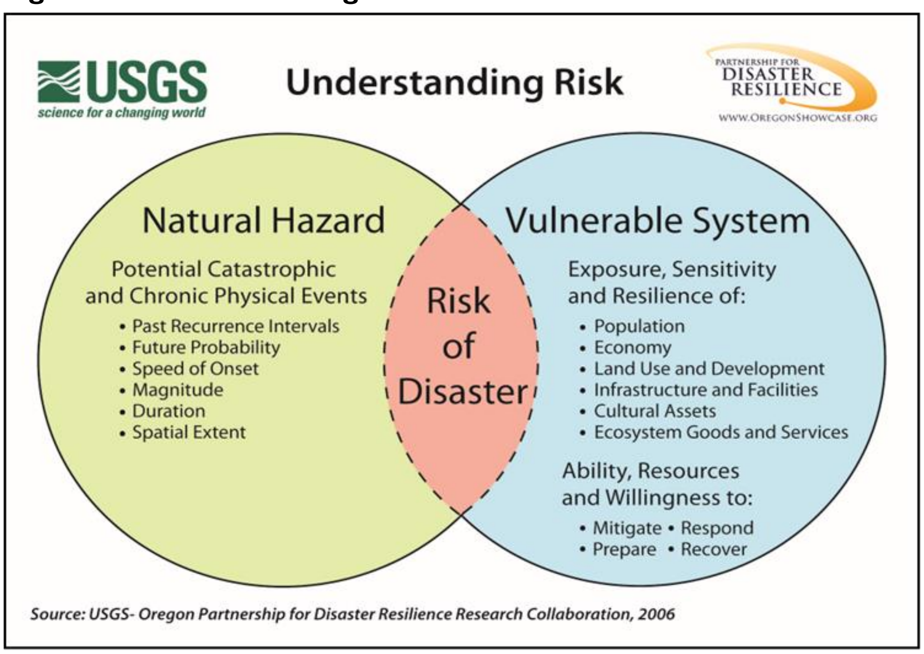
Appendix C: Community Profile

Community resilience can be defined as the community's ability to manage risk and adapt to natural hazard impacts. It is the measure of the sustained ability of a community to use available resources to respond to, withstand, and recover from adverse situations (Rand). The following capacities will be examined to help define and understand City of Salem's resilience to natural hazards:

- History
- Natural Environment
- Socio-demographic Capacity
- Economic Capacity
- Built (or Infrastructure) Capacity
- Community Connectivity
- Political Capital

The Community Profile describes the sensitivity and resilience to natural hazards of Salem 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 city. The information in this section, along with the hazard assessments located in the Risk Assessment (Volume I: Section 2), should be used as the local level rationale for the risk reduction actions identified in Mitigation Strategy (Volume I: Section 3). The identification of actions that reduce the city's sensitivity and increase its resiliency assist in reducing overall risk of disaster, the area of overlap in the figure below.

Figure C-1 Understanding Risk



Source: Institute for Policy Research and Engagement

History

This history and description of the City of Salem is directly excerpted from the Oregon Encyclopedia, a Project of the Oregon Historical Society (Lewis, 2022).

> Salem, the capital of Oregon, is located at a crossroads of trade and travel on former prairie lands along the Willamette River. The city was designated the seat of Marion County in 1849 and the territorial capital in 1851-1852. Incorporated in 1857, Salem served as the de facto state capital beginning in 1859 and, by popular vote, became the official capital in 1864. It is on the site of one of the earliest American settlements in the Oregon Country, a Methodist mission established by Jason Lee in 1841 near the Kalapuyan village of Tchimikiti. Lee established a town near the mission, which he named Chemeketa. In 1846, William Willson renamed it Salem, from the Arabic word salam, which means peace.
>
> To the south of the city are the Salem Hills, originally called the Red Hills, a midvalley geologic formation of ancient Jory soils. To the north is Lake Labish, a marshland drained in the early twentieth century to create agricultural land, and to the east farms and small towns meet the foothills of the Cascade Range. Salem's western boundary ended at the Willamette River until 1949, when West Salem was incorporated into the city. The city is in two counties, Marion to the east of the Willamette River and Polk to the west.
>
> Salem is drained by Mill Creek (Chemeketa Creek) and Pringle Creek (Harbor Creek), tributaries of the Willamette River. During the nineteenth century, the two creeks were joined by mill races to operate sawmills, grist mills, and woolen mills. Salem gets its water from the North Fork of the Santiam River, which was joined to Mill Creek by the Salem Ditch in 1857 to create better mill-race flows and provide clean drinking water.
>
> Salem vies with Eugene as the second most populous city in Oregon (after Portland). The city's population was 1,137 in 1870, and it has doubled or tripled every decade since, with the most dramatic change occurring between 1870 and 1880, when the population grew by 122%. In 2020, the city had 175,535 residents, 23% of them Latinx.

Additional information about Salem generally is provided from the Oregon Encyclopedia (City of Salem (oregonencyclopedia.org)) and excerpted throughout this community profile.

Natural Environment

City of Salem's natural environment is a product of geography, climate, ecozone, land use, and settlement patterns. The capacity of the natural environment is composed of elements known as natural capital. Natural capital is essential in sustaining all forms of life including human life, yet it often plays an underrepresented role in community resiliency to natural hazards. Natural capital includes land, air, water, and other natural resources that support and provide space to live, work and recreate (Mayunga, 2007). Natural capital 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 natural systems are impacted or depleted by human activities, those activities can adversely affect community resilience to natural hazard events.

Geography

The City of Salem is located in the north-central Willamette Valley, which lies between the Coast and the Cascade Mountain Ranges. The 45th Parallel (roughly the halfway point between the North Pole and the Equator) passes through Salem's city limits. The average elevation within the city limits is 154 ft. above sea level, according to the Oregon Blue Book, ranging from 120 ft. around the Willamette River to 800 ft in the surrounding hills (Oregon Secretary of State). Salem contains the volcanic Salem Hills in the south and is positioned between the 1,000 ft. Eola Hills directly to the west and the 600 ft. Waldo Hills to the east.

According to the U.S. Census Bureau, the city has a total area of 48.45 square miles (125.48 km^2), of which 47.90 square miles (124.06 km^2) is land and 0.55 square miles (1.42 km^2) is water. The city is located on the east and west banks of the Willamette River. The intersection of Oregon Route 22 and U.S. Interstate 5 occurs at the southwestern region of Salem. Oregon Route 99E travels through the center of the city.The primary river that flows through Salem is the Willamette River; other important streams that pass through are Mill Creek, the Mill Race, Pringle Creek, and the Shelton Ditch. Smaller streams in the eastern part of the city include Clark Creek, Jory Creek, Battle Creek, Croisan Creek and Clagget Creek, while glen Creek and Brush Creek flow through West Salem (Salem Online History).

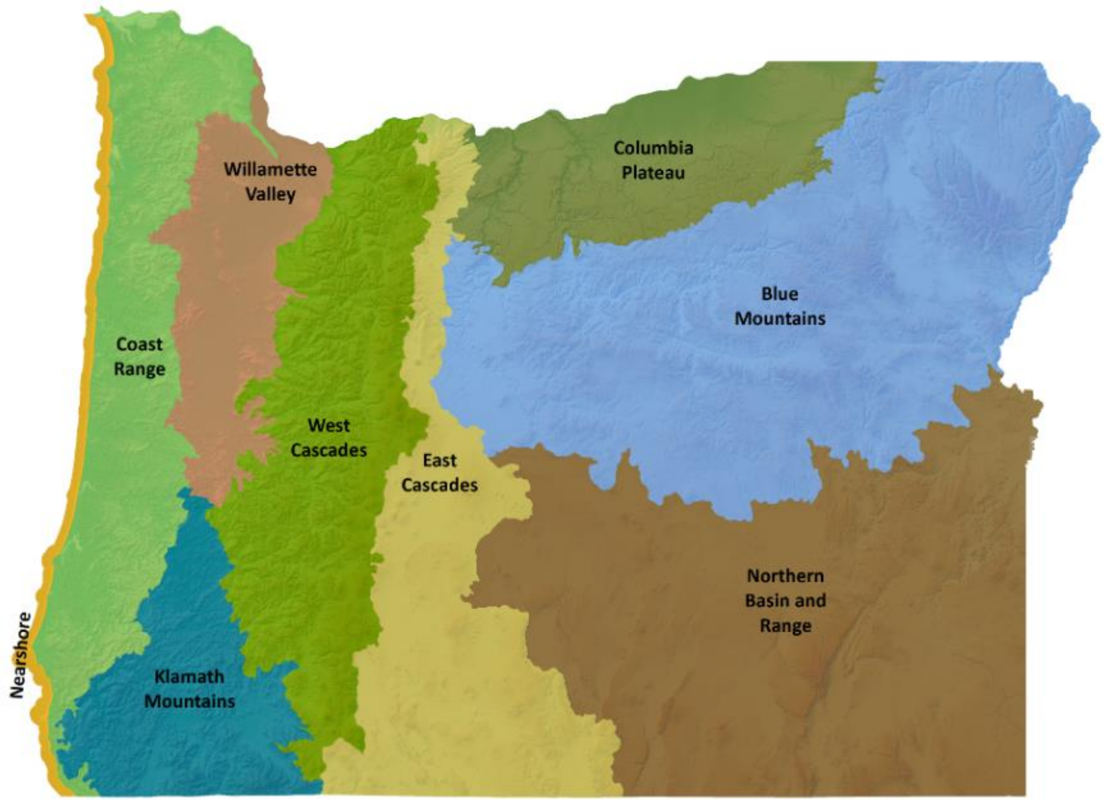
According to Salem's Annual Water Quality Report 2022, the North Santiam River has served as the primary water source for Salem for over 80 years. Surface water is conveyed by gravity from the North Santiam River, which begins on the west side of the Cascade Range, near Mt. Jefferson and Three Fingered Jack. The North Santiam River flows for over 90 miles from the Cascade Range, through Detroit Reservoir, and toward the Mid-Willamette Valley, ultimately joining the Willamette River. According to the City of Salem, the city's average summer water use is over 50 million gallons with an average winter use of roughly 22 million gallons.

Physical Geography and Ecoregions

Figure C- below is a map that shows the physiographic provinces of Oregon. Physiographic is the physical geography. Land is often described in terms of ecoregions. According to the Environmental Protection Agency (EPA), ecoregions are areas where ecosystems (and the type, quality, and quantity of environmental resources) are similar. In *Level III and IV Ecoregions of Oregon*, the EPA states,

> Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources; they are designed to serve as a spatial framework for the research, assessment management, and monitoring of ecosystem components. By recognizing the spatial differences in the capacities and potentials of ecosystems, ecoregions stratify the environment by its probable response to disturbance.

Figure C-2 Physiographic Provinces of Oregon



Source: Oregon Conservation Strategy

Salem is in the Willamette Valley physiographic province. According to the Oregon Conservation Strategy, the Willamette Valley ecoregion encompasses 5,308 square miles and includes the Willamette Valley and adjacent foothills. The valley is a long, level alluvial plain with scattered groups of low basalt hills. Fertile soil and abundant rainfall make the valley the most important agricultural region in Oregon.

Current and Projected Weather and Climate

Weather is how the atmosphere is behaving and its effects upon life and human activities. Weather can change from minute-to-minute. Most people think of weather in terms of temperature, humidity, precipitation, cloudiness, brightness, visibility, wind, and atmospheric pressure. Climate is the description of the long-term pattern of weather in a place. Climate can mean the average weather for a particular region and a period of 30 years. Climate is the average of weather over time (Best Places).

Like most of the Willamette Valley, Salem has a mediterranean climate where winters are cool and wet, and summers are moderately warm and dry (Wikipedia, 2023). According to NOAA's Local Climatological Data, the average annual precipitation is approximately 40.08 inches with the heaviest rainfall in late fall and winter. While major snow falls are rare, Salem does report an average annual snowfall of 6.2 inches.

The weather and climate of Salem and Marion and Polk Counties are discussed in the Risk Assessment. Marion County is in Climate Divisions 2 and 4 as seen in Figure 55. Salem is in Climate Division 2.

Based on the report *A Framework for Addressing Rapid Climate Change* by the Climate Change Integration Group,[17] localized climate projections for the regions within Oregon must be developed; these localized assessments are essential for both the public and private sectors to respond to climate change.

In the *2020 Oregon NHMP*, the U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Within the *2020 Oregon NHMP*, Oregon's Natural Hazard Regions are identified as 1 through 8. We refer to the *2020 Oregon NHMP* for climate change information about the Mid/Southern Willamette Valley Region (Region 3). Region 3 includes Linn, Lane (non-coastal), Marion, Polk, and Yamhill Counties. The hazards faced by Region 3 that are projected to be influenced by climate change include drought, wildfire, flooding, landslides, and extreme heat. The Fifth Oregon Climate Assessment Report: State of Climate Science: 2021 provides a comprehensive assessment of the state of climate change as it pertains to Oregon. It covers the physical, biological, and social dimensions. In summary, it notes the following assessments:

State of Climate Science

- *Temperature. Oregon's annual average temperature increased by about 2.2°F per century since 1895*
- *Precipitation. Precipitation is projected to increase during winter and decrease during summer.*
- *Snowpack and runoff. Snowpack throughout Oregon, especially on the west slope of the Cascade Range, is accumulating more slowly, reaching lower peak values, and melting earlier.*
- *Science advances. In addition to simulations of future climate from the newest generation of global climate models, advances in climate science have improved the accuracy of climate forecasts one week to one month into the future.*

Climate-Related Natural Hazards

- *Extreme heat. The frequency and magnitude of days that are warmer than 90°F is increasing across Oregon.*
- *Drought. Over the past 20 years, the incidence, extent, and severity of drought in the Northwest increased.*
- *Wildfire. Wildfire dynamics are affected by climate change, past and contemporary land management and human activity, and expansion of non-native invasive grasses.*
- *Floods. Flood magnitudes in Oregon are likely to increase.*

[17] The Climate Change Integration Group (CCIG) was convened to oversee implementation of the recommendations from the 2004 Advisory Group; to assess the current state of knowledge about the sensitivity, adaptive capacity and vulnerability of natural and human systems to global warming; and to prepare recommendations about how Oregon can adapt to unavoidable changes (State of Oregon Biennial Energy Plan 2013-15)

- *Coastal hazards. Sea-level rise, storminess, sediment supply, and human adaptation measures influence whether a given stretch of Oregon's coastline has eroded or built up in recent decades.*
- *Marine and coastal change. Off the Northwest coast, the open-ocean surface temperature increased by more than 1.2 ± 0.5°F since the year 1900 and is projected to increase by about another 5.0 ± 1.1°F by the year 2080.*

Adaptation Sectors

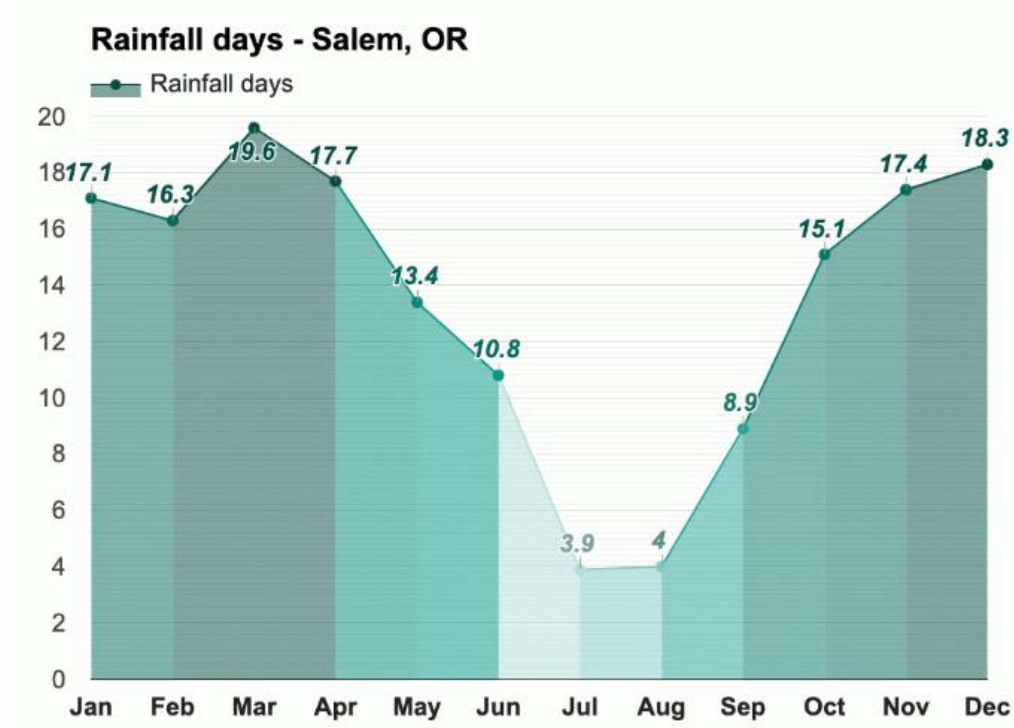
- *Natural systems. Climate change is affecting the timing of seasonal events in the life cycle of some plants and animals, and the viability of some species.*
- *Built environment. Climate change is likely to stress Oregon's infrastructure.*
- *Public health. Racial and economic injustices have created disparities in health outcomes among populations in Oregon. Black, Indigenous, and People of Color; underinvested rural, Tribal, and low-income communities; the young and the old; and those with pre-existing conditions or disabilities are more likely to experience negative health effects of climate extremes.*
- *Tribal cultural resources. Tribes may experience distinct impacts of climate change that relate to their cultures, identities, histories, relations with other governments, and land-holding status.*
- *Social systems. Social, political, and economic systems mediate the effects of climate change.*

Section 2, Risk Assessment, contains hazard-specific information. In addition, the Risk Assessment includes climate information and describes in full the Hazard Vulnerability Assessment (HVA). Climate data such as precipitation and temperature are presented below and provides a framework for understanding the weather and climate in Salem and Marion and Polk Counties.

Precipitation, Rainfall, and Snowfall

As a summary and a comparison with the rest of the U.S., here are some statistics from Best Places for Salem. Salem's annual precipitation is 44.9 inches. The U.S. average is 38 inches of rain per year. Salem averages 3.9 inches of snow per year; however, not every year there is snowfall. The U.S. average is 28 inches of snow per year. On average, there are 154 sunny days per year in Salem. The U.S. average is 205 sunny days. Salem gets some form of precipitation, on average, 151.5 days per year. Precipitation is rain, snow, sleet, or hail that falls to the ground. For precipitation to be counted there must be at least .01 inches on the ground to measure. Rain is heaviest in late fall and throughout winter, and all the annual precipitation falls between October and April. The dry season for Salem is May through September. Figure C-3 illustrates the average monthly rainfall days for the Salem area.

Figure C-3 Average Monthly Rainfall Days, Salem, Oregon



Source: Weather Atlas

Temperature

August is the hottest month for Salem with an average high temperature of 81.6 degrees, which ranks it cooler than most places in Oregon. In Salem, there are four comfortable months with high temperatures in the range of 70-85°. The most pleasant months of the year for Sweet Home are September, July, and August, according to Best Places. There are approximately 12.5 days annually when the high temperature is over 90 degrees.

December has the coldest nighttime temperatures for Salem with an average of 34 degrees. This is warmer than most places in Oregon. Salem has very few days annually when the nighttime low temperature falls below zero degrees.

Clouds and Sun

According to Weather Spark for Salem, the average percentage of the sky covered by clouds experiences extreme seasonal variation over the course of the year. The clearer part of the year in Salem begins around June and lasts for about four months, ending around October. The clearest month of the year is August, during with the sky is clear, mostly clear, or partly cloudy 78% of the time. The cloudier part of the year begins about October and lasts for over eight months, ending around June. The cloudiest month of the year is January, during which the sky is overcast or mostly cloudy 73% of the time.

The length of the day in Salem varies significantly over the course of the year. According to Weather Spark, for 2023 the shortest day is December 21 (8 hours, 46 minutes) and the longest day is June 21 (15 hours, 37 minutes). The earliest sunrise is at 5:25 AM on June 15, and the latest sunrise is at 7:54 AM on November 4. The earliest sunset is at 4:30 PM on December 9, and the latest sunset is at 9:02 PM on June 26.

Wind

This section discusses the wide-area hourly average wind vector (speed and direction) at 10 meters above the ground. The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages.

The average hourly wind speed in Salem experiences mild seasonal variation over the course of the year, according to Weather Spark. The predominant average hourly wind direction in Salem also varies throughout the year. The windier part of the year is typically from October to April, with average wind speeds of more than 5.5 miles per hour. The windiest month of the year in Salem is December, with an average hourly wind speed of 6.1 miles per hour. The calmer time of year is typically from April to October. The calmest month of the year in Salem is August, with an average hourly wind speed of 4.7 miles per hour.

Hazard Severity

Oregon’s Department of Land Conservation and Development (DLCD) contracted with the Oregon Climate Change Research Institute (OCCRI) to analyze the influence of climate change on natural hazards. The scope of the analysis that yielded the report entitled Future Climate Projections Marion County, Oregon is limited to the geographic area encompassed by Marion County, however OCCRI has performed this analysis for many other Oregon counties to inform the Natural Hazard Mitigation Plan update process. A small portion of Salem is in Polk County; however, OCCRI has not executed a Future Climate Projections report for Polk County. Based on the commonality between the two counties when it comes to current and future climate projections, this NHMP relies on the Marion County report issued in June 2022.

The Future Climate Projections Marion County, Oregon report states,

> 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). Climate change is expected to increase the likelihood of natural hazards such as heavy rains, river flooding, drought, heat waves, wildfires, and episodes of poor air quality, and to decrease the likelihood of cold waves.

The complete OCCRI Future Climate Projections Marion County, Oregon report is discussed in more detail in Section 2, Risk Assessment, and is available as Appendix E.

Land Cover

Salem has a mix of residential, commercial, and industrial land uses. The central business district is in the core of downtown Salem, to the east of the Willamette River. Residential zoned lands emanate in all directions from the downtown. In many areas, including West

Salem, agricultural use lands buffer in between the urban growth boundary and residential zoned areas. Due to the expansive network of rivers and streams throughout Salem, many residential, commercial and industrial zoned lands can be impacted by potential flooding, in the event the Willamette River and other local creeks and streams overflow their banks. The built environment is discussed in more detail below.

Synthesis

The physical geography, weather, climate, and land cover of an area are interrelated systems that affect overall risk and exposure to natural hazards. Climate change variability also has the potential to increase the effects of hazards. These factors combined with a growing population 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. Climate change is further discussed as part of the Risk Assessment (Volume I: Section 2), and throughout the identified hazards.

Socio-demographic Capacity

Socio-demographic capacity characterizes the community population in terms of language, race and ethnicity, age, income, educational attainment, and health. These attributes can significantly influence the community's ability to cope, adapt to, and recover from natural disasters. In addition to those described the status of other socio-demographic capacity indicators such as graduation rate, quality of schools, median household income can have long term impacts on the City of Salem economy and stability of the community affecting future resilience. These factors that are vulnerabilities can be reduced with outreach and mitigation planning.

Population

The population of the City of Salem in 2022 was estimated to be 179,642, according to the Population Research Center at Portland State University (PSU).[18] Salem is located within Marion and Polk Counties, divided by the Willamette River, with most of the population located in Marion County. Based on Population Research Center's 2020 population estimates, 86% of Salem's population is located within Marion County. Table C-1 and Table C-2 show the forecasted populations for Marion and Polk Counties, respectively, and their larger sub-areas (populations of over 8,000 by 2010), which Salem is one.

Table C-1 Marion County Forecasted Population

Source: Chen et al., 2021

Table C-2 Polk County Forecasted Population

	Population			Share of County Population		
	Estimates	Forecast		Estimates	Forecast	
	2020	2045	2070	2020	2045	2070
Polk County	86,805	128,783	189,106	100%	100%	100%
Outside UGBs	15,057	20,076	25,926	18%	15.6%	13.7%
Larger Sub-Area						
Dallas	17,201	27,568	43,635	20.5%	21.4%	23.1%
Independence	9,851	18,636	30,695	11.8%	14.5%	16.2%
Monmouth	10,022	16,527	24,034	12.0%	12.8%	12.7%
Salem (part)*	29,768	43,222	60,836	35.5%	33.6%	32.2%

Source: Chen et al., 2021

Biological Sex and Gender

[18] In 2013, the Oregon House of Representatives and Senate approved legislation assigning coordinated population forecasting to the Population Research Center at Portland State University. This method of population forecasting replaces the any previous county-coordinated 20-year population forecast. The Population Research Center produces the annual population estimates for Oregon and its counties and cities, as well as the estimates by age and sex for the state and its counties. These estimates are used by State and local governments, various organizations and agencies for revenue sharing, funds allocation, and planning purposes.

The concepts of sex and gender are often used interchangeably but are distinct; sex is based on biological attributes (chromosomes, anatomy, hormones) and gender is a social construction that may differ across time, cultures, and among people within a culture. Moreover, these two may differ across cultures and among people within a culture, and even across time (U.S. Census Bureau, 2021).

According to the U.S. Census Bureau, the sex question wording very specifically intends to capture a person's biological sex and not gender. Ambiguity of these two concepts interferes with accurately and consistently measuring what U.S. Census Bureau intends to measure--the sex composition of the population.

In FEMA's annual 2020 National Preparedness Report, it discusses the historically disadvantaged groups, such as the lesbian, gay, bisexual, transgender, queer (LGBTQ+) persons are "more likely than others to be severely impacted by disasters" (Frank, 2020). Research has shown that after a disaster, LGBTQ+ people are more likely to be socially isolated and face disrespect or harassment in settings such as emergency shelters.

Empirical research has begun to emerge about the ways in which gender influences resilience to disasters. It indicates that gender influence is much more pervasive and expressed differently among men, women, LGBTQ+, and non-binary populations than has been recognized (Enarson, 2017). This is an area deserving of more attention as the field develops

The 2020 U.S. Census gave people the option to identify a relationship as same sex. Furthermore, in July 2021, the U.S. Census Bureau, began asking Americans about their sexual orientation and gender identity through the Household Pulse Survey.[19] This survey measures how the coronavirus pandemic and other emergency issues are impacting households across the country from a social and economic perspective.

Based on the estimated 2022 population of the City of Salem at 179,642, there are slightly more females with 89,235 (approximately 49.7%) than males with 88,492 (approximately 49.3%). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities. The population pyramids in Figure C-5 and Figure C-6, below, show how the demographics of age and biological sex vary over time for Marion and Polk County, respectively.

Figure C-4, provided by Movement Advancement Project (MAP), is a profile of the state's LGBTQ+ population.

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[19] U.S. Census Bureau describes the Experimental Data Product, Household Pulse Survey, as the following:

> The U.S. Census Bureau, in collaboration with multiple federal agencies, is in a unique position to produce data on the social and economic effects of coronavirus on American households. The Household Pulse Survey was designed to deploy quickly and efficiently, collecting data to measure household experiences during the coronavirus pandemic. It has evolved to include content on other emergent social and economic issues facing households. Data will be disseminated in near real-time to inform federal and state action.

Figure C-4 Oregon Equity Profile

Percent of Adults (18+) Who are LGBTQ	Total LGBTQ Population (13+)	Percent of Workforce That is LGBTQ	Total LGBTQ Workers	Percent of LGBTQ Adults (25+) Raising Children
5.6%	207,000	6%	129,000	23%
Gallup/Williams 2019	*Williams 2020*	*Census 2018; Williams 2020*	*Williams 2020*	*Gallup/Williams 2019*

Source: Movement Advancement Project

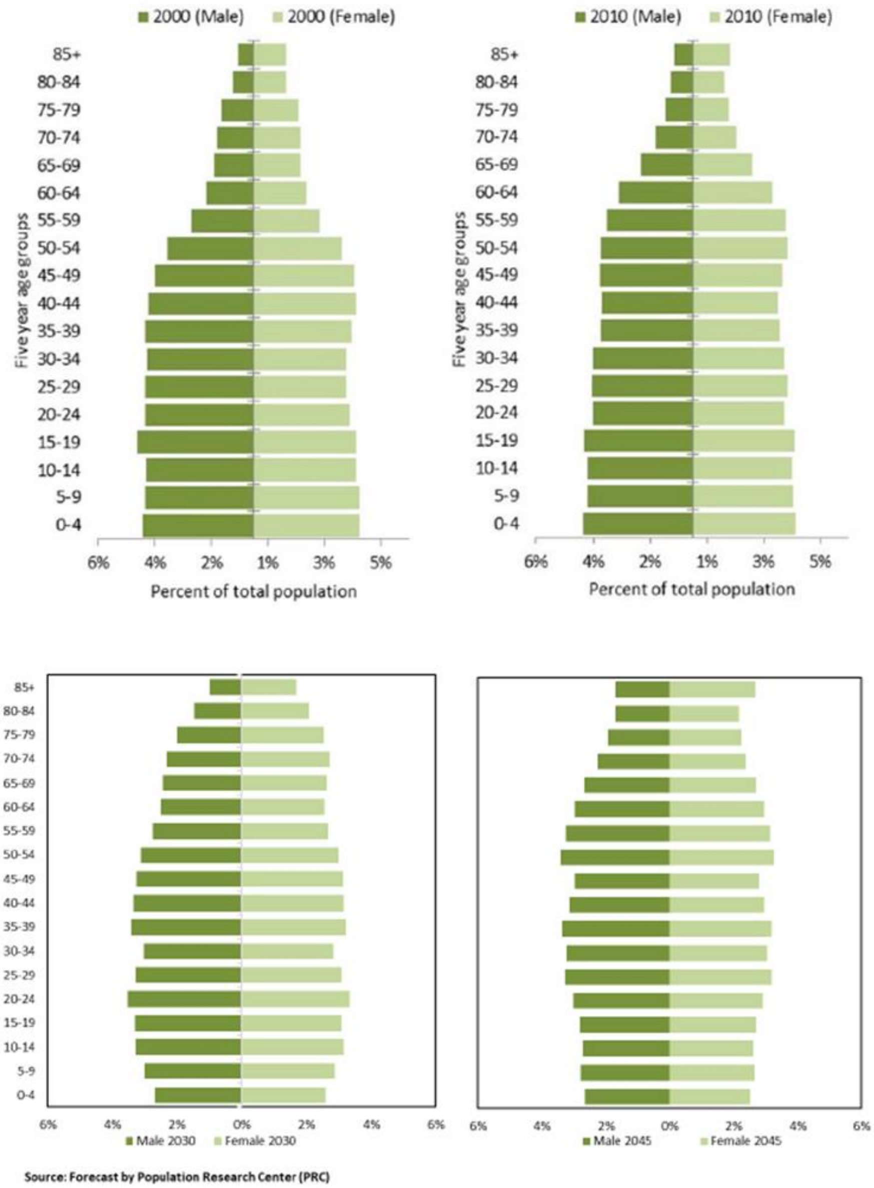
In 2017, the Human Rights Campaign Foundation's Municipal Equality Index, scored the City of Salem 90 out of 100, which ranked highest among Oregon cities at the time, with the most LGBTQ+ friendly policies and inclusiveness, scoring higher than Eugene and Portland (Woodworth, 2017). Potentially related to this ranking is City of Salem's Revised Code 97.005 that contains policy for the City of Salem to eliminate discrimination based on race, religion, color, sex, marital status, familial status, national origin, age, mental or physical disability, sexual orientation, gender identity and source of income. Moreover, the city's Human Rights Commission LGBTQ+ Intersectional Task Force was created in 2017 to address issues of LGBTQ+ rights in the community. Notwithstanding this information, outreach materials used to communicate with, plan for, and respond to underserved and under-represented populations such as LGBTQ+ persons should take into consideration the needs of this population.

Age

Of the factors influencing socio-demographic capacity, the most significant indicator in Salem may be age of the population. According to the U.S. Census American Community Survey, persons 65 years of age and older made up 15.0% of the total City of Salem population in 2021, increasing 1.7% in two years. Persons 18 years and younger comprised 24.2% of the population, a level that was nearly stable from the previous two years. Nationwide, the U.S. has a higher percentage of the population occurring in age cohorts between the ages of 55 and 74 than other age groups due to the "baby boom" which occurred after World War II (from 1946 to 1964) as is evident in the pyramid below in Figure C-5 and Figure C-6. Senior populations are typically more vulnerable to temperature extremes than other residents. The very young and very old share a proclivity for a wide range of conditions that require the support of family or community and, are more likely to thrive under consistent, accessible, comfortable conditions.

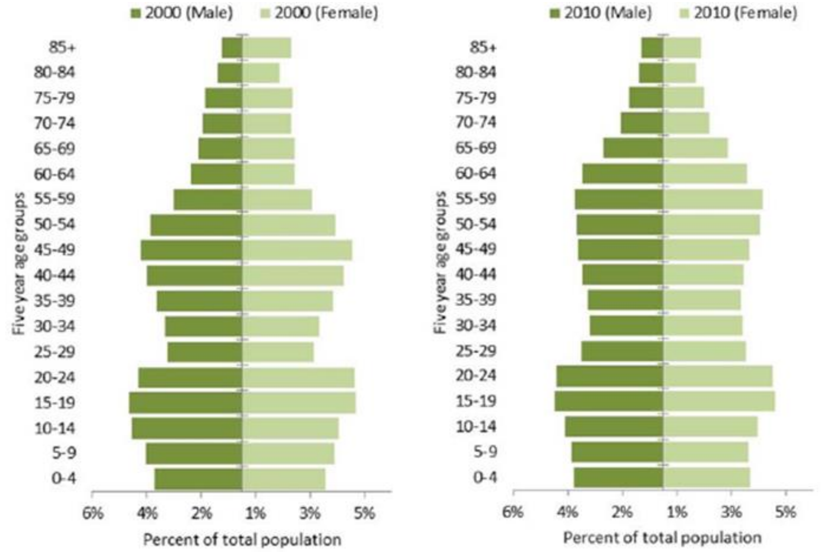
The population pyramids below show how the demographics of age and sex vary over time for Marion and Polk County, respectively.

Figure C-5 Marion County Population Pyramids for 2000, 2010, 2030 and 2045

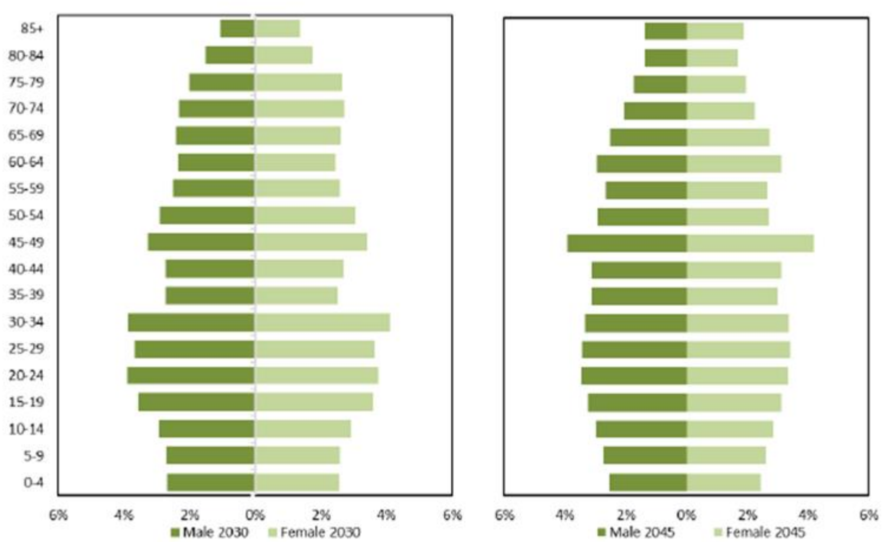


Source: Chen et al., 2021

Figure C-6 Polk County Population Pyramids for 2000, 2010, 2030 and 2045



Sources: U.S. Census Bureau, 2000 and 2010 Censuses. Calculated by Population Research Center (PRC).



Source: Forecast by Population Research Center (PRC)

Source: Chen et al., 2021

The age profile of an area has a direct impact both on what actions are prioritized for mitigation and how response to hazard incidents is carried out. School age children rarely make decisions about emergency management. Therefore, a larger youth population in an area will increase the importance of outreach to schools and parents on effective ways to teach children about fire safety, earthquake response, and evacuation plans. Furthermore, children are more vulnerable to the heat and cold, have few transportation options and require assistance to access medical facilities. Older populations may also have special needs prior to, during and after a natural disaster. Older populations may require assistance in evacuation due to limited mobility or health issues. Additionally, older populations may require special medical equipment or medications, and can lack the social and economic resources needed for post-disaster recovery (Wood, 2007)

Race and Language

Race is a social construct that can be used to understand a community's history and guide policies. The impact in terms of loss and the ability to recover may also vary among minority population groups following a disaster. Studies have shown that racial and ethnic minorities can be more vulnerable to natural disaster events. This is not reflective of individual characteristics; instead, historic patterns of inequality along racial or ethnic divides have often resulted in minority communities that are more likely to have inferior building stock, degraded infrastructure, or less access to public services.

Special consideration should also be given to populations who do not speak English as their primary language. Language barriers can be a challenge when disseminating hazard planning and mitigation resources to the public, and it is less likely they will be prepared if special attention is not given to language and culturally appropriate outreach techniques.

While English is the dominant language spoken in Salem, according to the 2020 U.S. Census, 40,244 people in City of Salem, or 24.1% (margin of error is +/- 4398 people) speak a language other than English at home. Of this non-English speaking population, 26,915 people speak Spanish at home and 7,914 people speak Asian and pacific Island languages (margin of error for both is +/- 4,204 and 1,964 people, respectively). 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 C-3 Population by Race in 2010 and 2020

City of Salem Population by Race	2010		2020	
	Pop.	%	Pop.	%
Total Population	154,637	100.0%	175,535	100.0%
Hispanic or Latino	31,600	20.43%	38,484	21.92%
White alone	122,213	79.03%	121,266	69.1%
Black or African American alone	2,283	1.48%	3,049	1.74%
Native American and Alaska Native alone	2,284	1.48%	2,924	1.66%
Asian Alone	4,215	2.73%	5,598	3.19%
Native Hawaiian and Other Pacific Islander alone	1,460	0.94%	2,373	1.35%
Some other race alone	15,545	10.05%	19,141	10.9%
Two or more races	6,637	4.29%	21,184	12.07%

Source: U.S. Census Bureau, 2010 and 2020.

It is important to identify specific ways to support all portions of the community through hazard mitigation, preparedness, and response. Culturally appropriate, and effective 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 will go a long way to increasing overall community resilience.

Health

Individual and community health play an integral role in community resiliency, as indicators such as health insurance, people with disabilities, dependencies, homelessness, and crime rate depict a picture of a community's overall well-being. These factors translate to a community's ability to prepare, respond to, and cope with the impacts of a disaster.

It is recognized that those who lack health insurance or are impaired with sensory, mental, or physical disabilities, have higher vulnerability to hazards and will may require additional community support and resources. On a similar note, a community with high percentages of drug dependency and violent crimes may experience increased issues with the disruption of normal social systems. It is likely that the continuity of services will be interrupted by a disaster.

According to the 2021 U.S. Census, it is estimated that 7.0% of the City of Salem population has a mobility (ambulatory) difficulty, and this expands to 24.5% of the population for people over 65. The population with a cognitive difficulty averages 6.9%, except people over 75 suffer cognitive difficulties at a rate of 11.6%. These patterns are similar for independent living—the average of 6.9% with a difficulty increases to 25.6% at 75 years or older.

Table C-4 Characteristics of the Disabled Population

	Total Population	%
City of Salem	172,066*	100%
With a Disability	23,914	13.9%
With a Hearing difficulty	5,355	3.1%
With a Vision difficulty	4,037	2.3%
With a Cognitive difficulty	11,063	6.9%
With an Ambulatory difficulty	11,266	7.0%
With a Self-Care difficulty	5,342	3.3%
With an Independent-Living difficulty	8,960	6.9%

Source: U.S. Census Bureau, 2021

There is a wide variation of the disabled population. Some individuals may have strong support structures and a high level of care provided to them by friends, neighbors, and care providers. Others may lack sufficient support. Some individuals may be self-reliant. In some cases, multiple risk factors, access limitations, or special needs can increase personal vulnerability.

Table C-5 Disabled Population

Age	%
Under 18 years	7.0%
18 to 64 years	24.0%
65 years and over	72.9%

Source: U.S. Census Bureau, 2021

Families and Living Arrangements

Two ways the census defines households are by type of living arrangement and family structure. A householder may live in a "family household" (a group related to one another by birth, marriage or adoption living together); in a "nonfamily household" (a group of unrelated people living together); or alone. According to the 2021 U.S. Census, Salem is predominately comprised of family households (64%). Of all households, 28.8% are one-person non-family households (householder living alone). About 13.3% of householders live alone and are over the age of 65.

Table C-6 Selected Households and Families

	Total Households	%
City of Salem	64,959	100%
Married-couple family household	30,730	47.3%
Single-parent family household	10,879	16.8%
Nonfamily household	23,350	35.9%
Householder living alone	18,708	28.8%

Source: U.S. Census Bureau, 2021

Table C-7 shows household structures by type and for families with children. These populations may require additional support during a disaster and may inflict strain on the system if improperly managed.

Table C-7 Selected Households by Type and Age of Own Children

	Total Households	%
City of Salem	64,959	100%
Households with own children of householder under 18	20,467	
Under 6 years only		23.8%
Under 6 years and 6 to 17		19.4%
6 to 17 years only		56.8%
Households with one or more people under 18 years		35.2%
Households with one or more people 60 years and over		37.7%
Households with one or more people 65 years and over		29.5%
Households living alone		28.8%
65 years and over		13.3%

Source: U.S. Census Bureau, 2021

Household income and poverty status are indicators of socio-demographic capacity and the stability of the local economy. Household income can be used to compare economic areas but does not reflect how the income is divided among the area residents. Table C- lists the distribution of household income and the median income in Salem in 2017 and 2021. Between 2017 and 2021 the share of households making less than $15,000 increased by 0.7%. Median household Income increased across Salem from $56,186 to $63,927.

Table C-8 Household and Median Income

Household Income	2017		2021		Change in Share	
	Households	%	Households	%	Households	%
Total	58,511	--	64,959	--	6,448	--
Less than $10,000		5.9%		4.9%		-1%
$10,000 to $14,999		3.8%		4.5%		0.7%
$15,000 to $24,999		10.0%		7.2%		-2.8%
$25,000 to $34,999		10.7%		7.1%		-3.6%
$35,000 to $49,999		13.8%		12.5%		-1.3%
$50,000 to $74,999		19.9%		20.5%		0.6%
$75,000 to $99,999		14.4%		13.6%		-0.8%
$100,000 to $149,000		14.1%		16.6%		2.5%
$150,000 to $199,999		4.5%		6.2%		1.7%
$200,000 or more		2.8%		7.0%		4.2%
Median income (dollars)	$56,186		$63,927		$7,741	
Mean income (dollars)	$70,161		$85,482		$15,321	

Source: U.S. Census Bureau, 2017 and 2021.

Table C-, below identifies the percentage of individuals and cohort groups that are below the poverty level in 2021. It is estimated that 12.8% of individuals, 14.3% of children under 18, and 9.5% of people 65 and older live below the poverty level in Salem.

Table C-9 Poverty Rates

	Total	Below Poverty Level	Percent Below Poverty Level
	Estimate	Estimate	Estimate
Population for whom poverty status is determined	168,778	21,659	12.8%
AGE			
Under 18	41,888	6,003	14.3%
18 to 64	100,906	13,188	13.1%
65 years and over	25,984	2,468	9.5%

Source: U.S. Census Bureau, 2021

Cutter's (2003) 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 rebound from a hazard event more quickly, 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 (Cutter, 2003)

Federal assistance programs such as food stamps are another indicator of poverty or lack of resource access. Statewide social assistance programs like the Supplemental Nutritional Assistance Program (SNAP) and Temporary Assistance for Needy Families (TANF) help individuals and families. In Salem, SNAP helped feed an estimated 14,515 or 22.3% of households in 2021, according to the U.S. Census Bureau. According to Office of Family Assistance (2022), between October 2020 and September 2021, the average number of monthly TANF program recipients in Oregon was 14,390. Those reliant on state and federal assistance are more vulnerable in the wake of disaster because of a lack of personal financial resources and reliance on government support.

In 2019, Oregon Housing and Community Services (OHCS) conducted a Point-in-Time (PIT) count[20] to identify the number of homeless, their age and their family type. The OHCS homeless count was conducted county-wide. The City of Salem is in Marion and Polk Counties, with most of its population located in Marion County. The OHCS 2019 PIT count found that 1,095 individuals and persons in families in Marion and Polk Counties (including Salem) identify as homeless; 526 were sheltered and 571 were unsheltered.

The homeless have little resources to rely on, especially during an emergency. It will likely be the responsibility of the city and local non-profit entities to provide services such as shelter, food and medical assistance. Therefore, it is critical to foster collaborative relationships with agencies that will provide additional relief such as the American Red Cross and homeless shelters. It will also be important to identify how to communicate with these populations, since traditional means of communication may not be appropriate or available.

Education

According to the City of Salem (2020), Salem has a K-12 school system, including public, parochial, and private schools, which educates over 41,000 students daily. The Salem-Keizer Public Schools is the second largest school district in Oregon. According to Salem's educational statistics, the median class size is 28 (2015-2016 class size report) and a 77% high school, on time, graduation rate (2018-19 data). Salem area is also home to Western Oregon University, Willamette University, Corban University, and Chemeketa Community College, which had cumulative enrollment of over 37,000 between 2017-2019.

Educational attainment of community residents is also identified as an influencing factor in socio-demographic capacity. Educational attainment often reflects higher income and therefore higher self-reliance. Widespread educational attainment is also beneficial for the regional economy and employment sectors as there are 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 resiliency of the community.

According to the U.S. Census, 24.9% of the Salem population over 25 years of age has graduated from high school or received a high school equivalency, with 17.2% going on to earn a bachelor's degree or higher.

20 The OHCS Point in Time (PIT) count, occurs once every two years, and is designed to enumerate persons living in homeless facilities and on the streets. It does not capture people who are staying a few nights with a relative, youth who are couch surfing temporarily, or those being put up in a garage or a barn

Table C-10 Educational Attainment

	Total	%
AGE BY EDUCATIONAL ATTAINMENT		
Population 18 to 24 years	18,753	
Less than high school graduate	2,939	15.7%
High school graduate (includes equivalency)	8,303	44.3%
Some college or associate degree	6,454	34.4%
Bachelor's degree or higher	1,057	5.6%
Population 25 years and over	115,980	
Less than 9th grade	6,094	5.3%
9th to 12th grade, no diploma	7,811	6.7%
High school graduate (includes equivalency)	28,853	24.9%
Some college, no degree	28,045	24.2%
Associate degree	11,663	10.1%
Bachelor's degree	19,943	17.2%
Graduate or professional degree	13,568	11.7%
High school graduate or higher	102,075	88.0%
Bachelor's degree or higher	33,514	28.9%

Source: U.S. Census Bureau, 2021

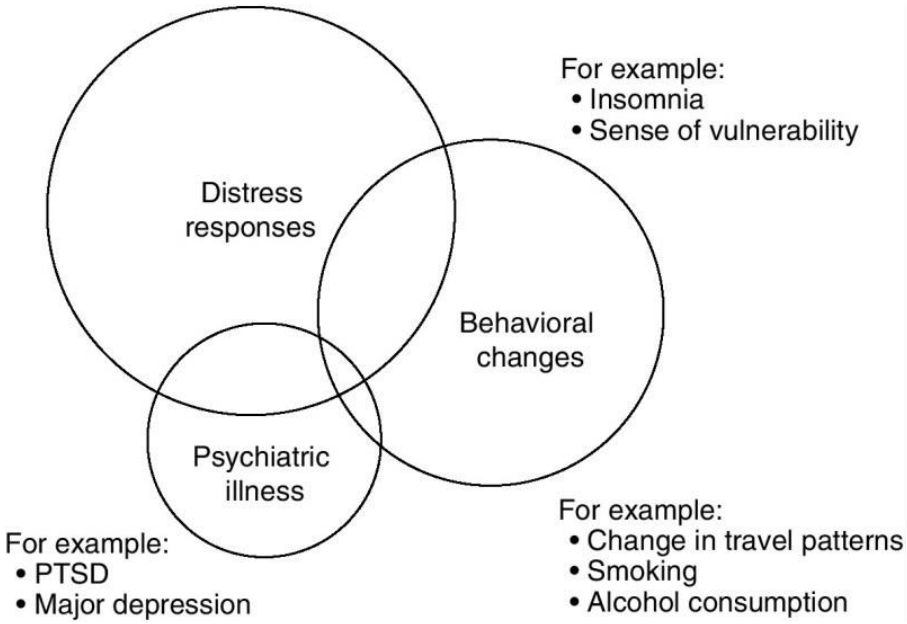
Mental Health and Trauma

Disaster conditions can aggravate anyone affected. For those who suffer from trauma or other mental illness, new stressors can be debilitating or have unpredictable result. Evidence of this is shown by a case study done following the Mt. St. Helens eruption disaster showing there was a marked increase in the caseload for mental health crisis services in the weeks following the eruption. Another important consideration is the ability of disaster conditions to cause mental illness. It is estimated that 10% of disaster victims can develop mental health problems, including depression, and substance abuse.

In *Preparing for the Psychological Consequences of Terrorism: A Public Health Strategy*, by Institute of Medicine (2003) it states,

> The effect of exposure to a traumatic event is variable and specific to the individual; both psychological and physiological responses can vary widely. Social context, biological and genetic makeup, past experiences, and future expectations will interact with characteristics of the traumatic experience to produce the individual's psychological response (Ursano et al., 1992). In general, those exposed to a traumatic event show increased rates of acute stress disorder, posttraumatic stress disorder (PTSD), major depression, panic disorder, generalized anxiety disorder, and substance use disorder (Kessler et al., 1995). Although psychiatric illnesses such as PTSD are the more severe outcomes of traumatic events, they are also the best studied

Figure C-7 Psychological consequences of disaster and terrorism



Source: Institute of Medicine, 2003 and Ursano, 2002.
Note: Indicative only; not to scale.

Experience of a traumatic event does not dictate a psychological problem but understanding the range of symptoms can help in understanding what type of support is needed.

Because disasters often result in the activation of mass care centers, sponsors of these centers may be particularly interested in addressing or understanding the effect of trauma on the populace. Providing compassion to the community by offering support services could be construed as a mental health intervention with positive benefits. This is sometimes called trauma-informed service or care when trauma is taken into consideration as something that may need to be addressed as a root cause of an individual or group problem.

For many, receiving community support to meet basic needs may resolve any observable impacts of a disaster on mental health. This is the definition of disaster "relief"—there are tangible physical and psychological benefits.

Management of congregate settings could include some form of monitoring to identify the level of stress or distress by common signs. For example, some people may be inclined to use coping mechanisms like smoking or alcohol. Others may be predisposed to a mental health crisis due to drug withdrawal. Unfortunately, psychiatric emergencies are a possible result of a disaster or its secondary impacts. Preparation for mass care should include training so that the causes and differences in psychiatric emergencies can potentially be identified, treated, or de-escalated before harm occurs.

Socially Vulnerability and Underserved Communities

Disasters are terrible because of the loss they bring. Anyone can experience a loss in their personal capabilities during or because of a disaster. This is particularly true for people already underserved or disadvantaged by one or more risk factors. Vulnerable populations present a special challenge to emergency managers and response agencies as they are more likely to have unique needs, and combinations of needs, which put them at risk of being victims of a disaster.

Vulnerable populations are those groups that possess specific characteristics that inhibit their ability to prepare for, respond to, or recover from a disaster. In addition, people from non-white or non-able-bodied populations may be considered "underserved."

The State of Oregon Equity Framework defines historically and currently underserved communities as Oregonians who are:

- Native Americans, members of Oregon's nine federally recognized tribes, American Indians, Alaska Natives
- Black, Africans, African Americans
- Latinx, Hispanic
- Asian, Pacific Islanders
- Immigrants, refugees, asylum seekers
- Undocumented, 'Development, Relief, and Education for Alien Minors' Act Recipients (DREAMers)
- Linguistically diverse
- People with disabilities
- LGBTQ+
- Aging/older adults
- Economically disadvantaged
- Farmworkers, migrant workers
- Living in rural parts of the state

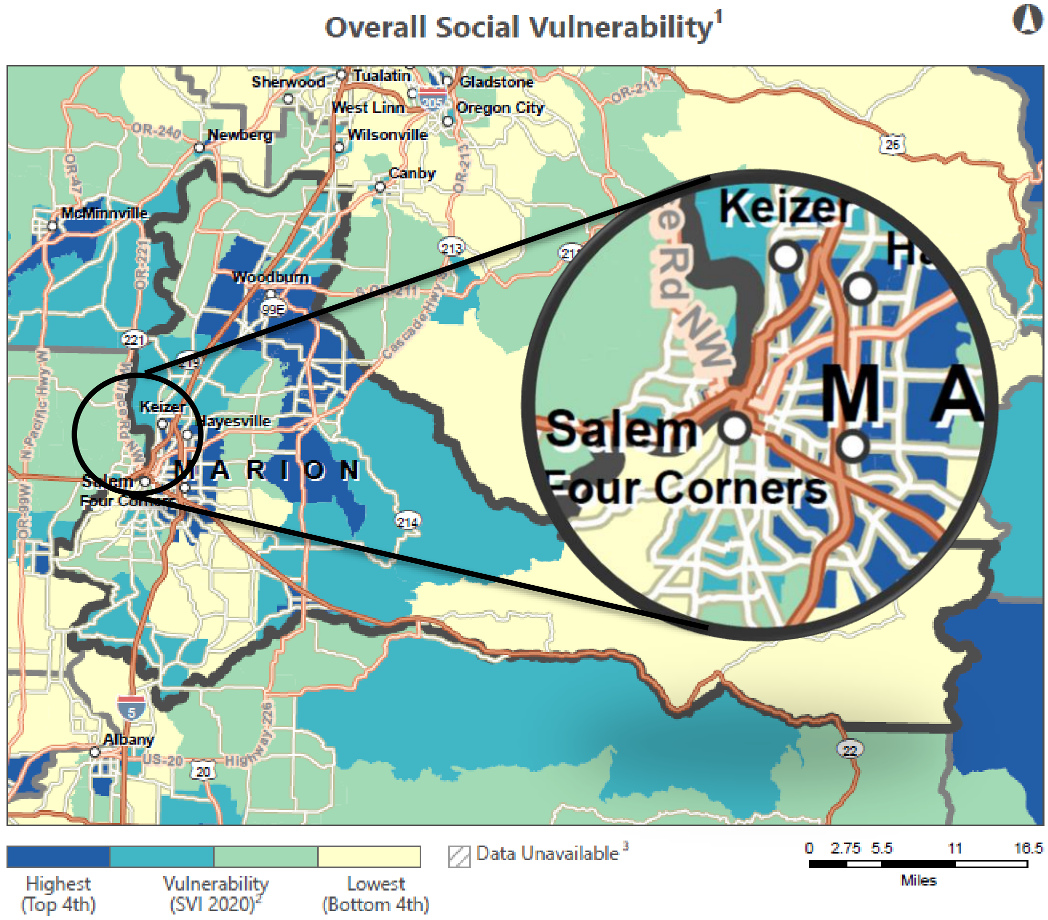
Individuals often identify with multiple communities and are impacted by compounding systems of oppression, also known as intersectionality. Identity and experience impact racial, health, and economic equity and should be considered in applying core elements that help decision makers center equity in their planning and response efforts (Office of Governor Kate Brown, 2020).

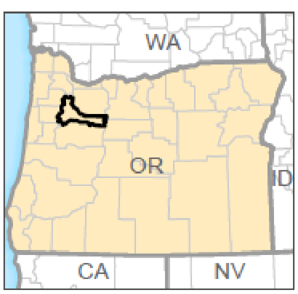
Figure C-8 Marion County Overall Social Vulnerability Index 2020, Salem Highlighted

CDC/ATSDR Social Vulnerability Index 2020

MARION COUNTY, OREGON

Overall Social Vulnerability[1]

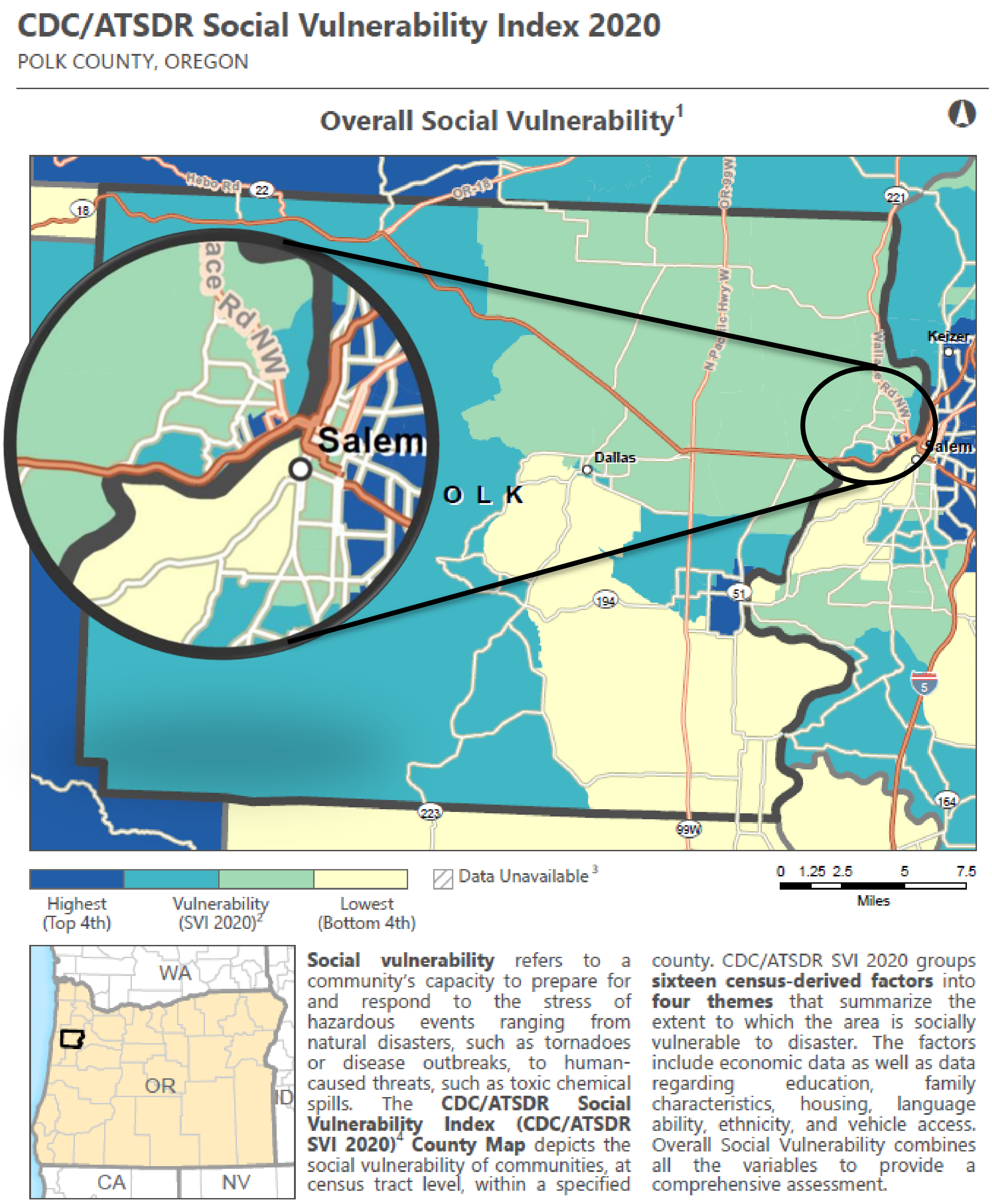




Social vulnerability refers to a community's capacity to prepare for and respond to the stress of hazardous events ranging from natural disasters, such as tornadoes or disease outbreaks, to human-caused threats, such as toxic chemical spills. The **CDC/ATSDR Social Vulnerability Index (CDC/ATSDR SVI 2020)**[4] **County Map** depicts the social vulnerability of communities, at census tract level, within a specified county. CDC/ATSDR SVI 2020 groups **sixteen census-derived factors** into **four themes** that summarize the extent to which the area is socially vulnerable to disaster. The factors include economic data as well as data regarding education, family characteristics, housing, language ability, ethnicity, and vehicle access. Overall Social Vulnerability combines all the variables to provide a comprehensive assessment.

Source: Agency for Toxic Substance and Disease Registry, 2020.

Figure C-9 Polk County Overall Social Vulnerability Index 2020, Salem Highlighted



Source: Agency for Toxic Substance and Disease Registry, 2020.

Tourist Population

Tourists are not measured in U.S. Census data so it can be difficult to document the number of visitors. According to Travel Salem's 2021-2022 Annual Report, visitor activity increased during the 2021-2022 annual reporting period, which rebounded from the COVID pandemic. During this time, City of Salem averaged approximately 520,000 room nights sold (Salem accounts for 72% of the Transient Occupancy Tax that's collected within the Marion and Polk Counties). In the 2022 Travel Economic Impact Report for Marion and Polk Counties, 66% of nights spent in the region were by travelers staying at a private home, while hotel, motel, and short-term rentals account for 27%.

Tourists are particularly vulnerable during natural hazard events. This is because tourists are usually unfamiliar with the hazards in the region and because they do not have the knowledge, or the materials needed to take care of themselves in a disaster. For example, a typical tourist, unfamiliar with Salem or Marion or Polk Counties, may have difficulty identifying or using evacuation routes, or finding shelters in the event of an earthquake. A typical tourist is less likely to have a supply of food, water, flashlights, radios, and other supplies that locals can use to take care of themselves in a disaster. And finally, tourists usually do not have a local support structure of family, friends, and neighbors.

Synthesis

For planning purposes, it is essential Salem consider both immediate and long-term socio-demographic implications of hazard resilience. Immediate concerns include the growing elderly population and language barriers associated with a culturally diverse community. Even though most of the population is reported as proficient in English, there is still a segment of the population not proficient in English. These populations would serve to benefit from mitigation outreach, with special attention to cultural, visual and technology sensitive materials. The status of other socio-demographic capacity indicators such as graduation rate, poverty level, and median household income can have long-term impacts on the economy and stability of the community ultimately affecting future resilience.

In mitigation and preparedness planning it is critical for the safety of all residents that messaging, and actions are culturally sensitive to all racial and ethnic groups. This may range from providing multi-lingual services to adopting entirely different strategies for outreach or specialized mitigation actions to address the unique risk faced by various racial and ethnic groups. For example, if multigenerational family units are more typical in some cultures, evacuation may be more take longer to accommodate the elderly and children living at home or could even be impeded if there is only one family car. Additionally, varying cultural perceptions of the trustworthiness of government may need to be overcome so that suggestions to evacuate or shelter in place are taken seriously by residents.

Economic Capacity

Economic capacity refers to the financial resources present, and revenue generated in the community to achieve a higher quality of life. Income equality, housing affordability, 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. Once any inherent strengths or systematic vulnerabilities become apparent, both the public and private sectors can take action to increase the resilience of the local economy.

Based on social science research, a region's cohesive response to a hazard event may be affected by the distribution of wealth in communities that have less income equality (Cutter, 2010).

Oregon State University together with The Oregon Community Foundation issued a report in 2015 that describes a comparison to all other states; Oregon has average levels of income inequality. Nationally, Oregon ranks 22nd among the 50 states and Washington D.C., where ranking 1st means having the lowest inequality and ranking 51st means having the highest inequality. Oregon's level of inequality is slightly below the national average (Rahe et al., 2015; Ruffenach and Worcel, 2017).

According to an Oregon Employment Department article dated July 24, 2018, Barbara Peniston states,

> The degree of wage inequality in Oregon has generally increased since 1990, though not steadily. The state's Gini coefficient for all year-round workers rose from 1991 through the mid-1990s, and then was relatively level before rising to a peak in 2000. Since 2000, the coefficient fell slightly in 2001 and 2002, during the first economic slowdown of the decade. Afterwards, it began a steady rise to a second peak in 2007, as the state's economy recovered from the recession earlier in the decade. The coefficient decreased a little again in 2008 and 2009 and subsequently rose to reach its highest point in 2015. It dropped slightly in 2016 and remained essentially unchanged in 2017.

Regional Affordability

The evaluation of regional affordability supplements the identification of Socio-demographic capacity indicators, such as. median income and is a critical analysis tool to understanding the economic status of a community. This information can capture the likelihood of individuals' ability to prepare for hazards, through retrofitting homes or purchasing insurance. If the community reflects high-income inequality or housing cost burden, the potential for homeowners and renters to implement mitigation can be drastically reduced. Therefore, regional affordability is a mechanism for generalizing the abilities of community residents to get back on their feet without Federal, State or local assistance.

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 persons have a similar income. The Gini index is a measure of income inequality. 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). The Gini is based on the difference between the Lorenz curve (the observed cumulative income distribution) and the notion of a perfectly equal income distribution (U.S. Census Bureau, 2021).

Salem has a Gini coefficient of 0.44. Based on social science research, the region's cohesive response to a hazard event may be affected by the distribution of wealth in communities that have less income equality (Cutter, 2010).

Table C-11 Regional Income Equality

Jurisdiction	Income Inequality Coefficient
Oregon	0.46
Marion County	0.43
Polk County	0.42
Salem	0.44

Source: U.S. Census Bureau

Housing Affordability

Housing affordability is a measure of economic security gauged by the percentage of a metropolitan area's households paying less than 35% of their income on housing (University of California Berkeley). Households spending more than 35% are considered housing cost burdened. In general, the population that spends more of their income on housing has proportionally fewer resources and less flexibility for alternative investments in times of crisis (University of California Berkeley). Table C- below displays the percentage of homeowners and renters reflecting housing cost burden across the region.

Table C-12 Housing

	Salem	U.S.
Housing Units, July 1, 2022 (V2022)	X	143,786,655
Owner-occupied housing unit rate, 2017-2021	54.9%	64.6%
Median value of owner-occupied housing units, 2017-2021	$289,500	$244,900
Median selected monthly owner costs-with a mortgage, 2017-2021	$1,681	$1,697
Median selected monthly owner costs-without a mortgage, 2017-2021	$618	$538
Median gross rent, 2017-2021	$1,125	$1,163
Building permits, 2022	X	1,665,088

Source: U.S. Census Bureau QuickFacts

High incidence of housing cost burden can impose serious challenges for a community recovering from a disaster, as housing costs may exceed the ability of residents to repair or move to a new location. These populations may live paycheck to paycheck and are extremely dependent on their employer. In the event their employer is also impacted, it will further the detriment experienced by these individuals and families.

Economic Diversity

Economic diversity is a general indicator of an area's fitness for weathering difficult financial times, but it is not a guarantor of economic vitality or resilience (University of California Berkeley). Business activity in the Willamette Valley region is homogeneous and consists mostly of small businesses.

One method for measuring economic diversity is through use of the Herfindahl-Hirschman Index (HHI), a formula that compares the composition of city and regional economies with those of states or the nation. Using the HHI, a diversity ranking of 1 indicates the city with the most diverse economic activity compared to the state, while a ranking of 36 corresponds with the least diverse city economy. The table below describes the HHI-score for counties in the region.

Table C-13shows that Marion and Polk Counties have economic diversity rankings of 12 and 20 respectively as of 2021 (Tauer, 2022). 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 C-13 Regional Herfindahl Index Scores

	2021		1999	
County	**Value**	**Rank**	**Value**	**Rank**
Benton	0.628	7	0.292	27
Lane	0.859	1	0.848	1
Linn	0.555	11	0.621	9
Marion	0.492	12	0.481	14
Polk	0.360	20	0.428	17
Yamhill	0.404	16	0.510	10

Source: Tauer, 2022

Note: Values range from zero to 1.00; higher values indicate a more diverse economy. The 2018 Hachman Index values are based on 3-digit NAICS industry breakouts, while the 1999 values are based on 2-digit SIC industry breakouts.

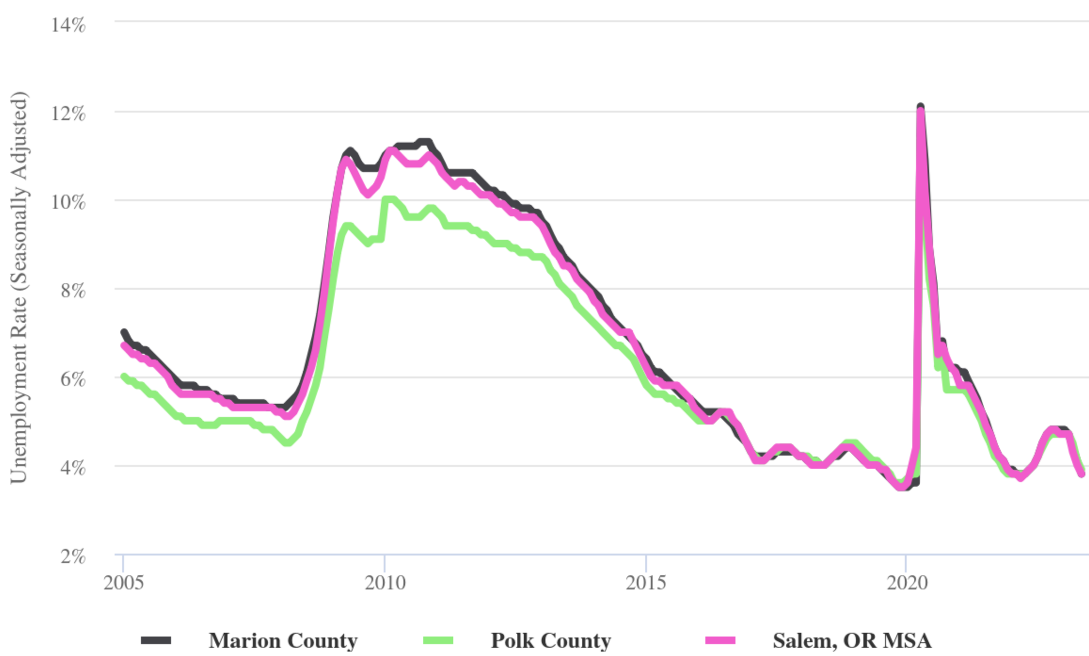
While illustrative, economic diversity is not a guarantor of economic vitality or resilience. The Oregon Employment Department designates counties, cities, communities, or other geographic areas experiencing high unemployment, poverty, and job loss as economically distressed. The Distressed Cities List is used to highlight Oregon communities that may need additional support. The distressed designation may provide a community with an advantage if it applies for funds from state and federal sources. Business Oregon gives priority when funding technical assistance, programs and projects to geographic areas determined to be economically distressed as prescribed by Oregon law. According to Business Oregon, as of 2022, Salem 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.

Employment and Wages

According to the Oregon Employment Department, unemployment has declined since a high of 11.5% in April 2009. As of May 2023, the unemployment rate for Marion and Polk Counties are 3.8% and 3.9%, respectively. The City of Salem has a 3.8% unemployment rate as of the same date.

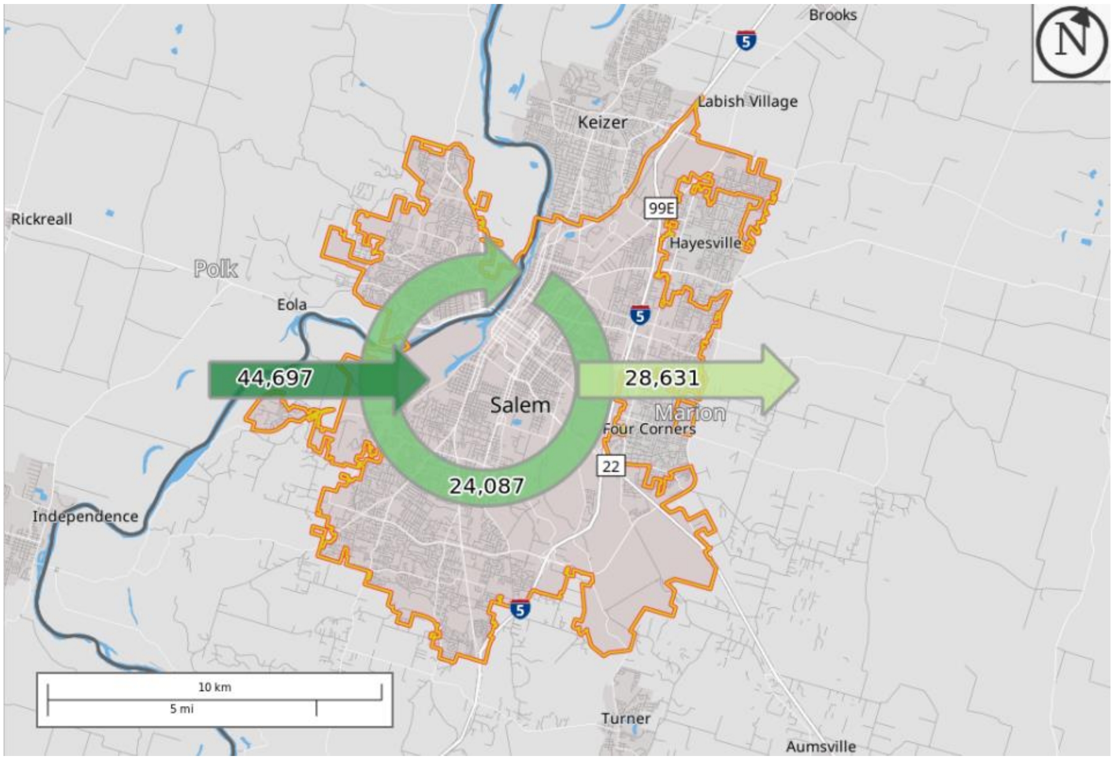
Figure C-10 Unemployment Rate



Source: Oregon Employment Department, 2023

Salem employers draw in about two-thirds (65%) of their workers from outside the city. The Salem economy is a cornerstone of regional economic vitality. Figure C-5 shows the city's laborshed as of 2020; the map shows that about 35% of workers live and work in the city (24,087), 65% of workers come from outside the city (44,697), and about 54.3% of residents work outside of the city (28,631).

Figure C-11 Salem Laborshed



Source: U.S. Census Bureau, 2020.

Mitigation activities are needed at the business level to ensure the health and safety of workers and limit damage to industrial infrastructure. 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 Salem residents and businesses.

According to the U.S. Census (2021), approximately 73.5% of commuters travel by car; 65.2% of these individuals commute alone while 8.3% carpool. In addition, 0.8% used public transportation, 3.7% walked, 1.4% used a bicycle, 0.4% used a taxicab, motorcycle or other means, and 20.2% worked from home. Increased commuting creates a greater dependency on roads, communications, accessibility, and, in the event of a hazard incident, emergency evacuation routes to reunite people with their families. Before a natural hazard event, large or small businesses can develop strategies to prepare for natural hazards, respond efficiently, and prevent loss of life and property.

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 those industries' specific sensitivities. The *2020 Oregon Natural Hazards Mitigation Plan* indicates that for the Mid/Southern

Willamette Valley (Region 3), it is important to recognize that the impact that a natural hazard event has 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 (*2020 Oregon NHMP*).

Employment by Industry

Economic resilience to natural disasters is particularly important for the major employment industries in the region. If a natural hazard negatively impacts these industries, such that employment is affected, the impact will be felt throughout the regional economy (*2020 Oregon NHMP*). Thus, understanding and addressing the sensitivities of these industries is a strategic way to increase the resiliency of the entire regional economy.

Salem relies on both basic and non-basic sector industries, and 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. While Salem has some basic industries, such as Manufacturing; four out of their five largest industrial sectors are of the non-basic nature and thus they rely on local sales and services. Trending towards basic industries can lead to higher community resilience. Table C-14 shows the top industry sectors in the Salem area.

Table C-14 Salem's Top Industry Groups

Industry	Businesses	Employees	% of Total
Trade, transportation, and utilities	1,975	28,605	15.9%
Education and health services	1,424	28,933	16.1%
Leisure and hospitality	1,070	15,742	8.8%
Manufacturing	503	13,171	7.3%
Professional and business services	1,810	15,244	8.5%
Natural resources and mining	661	11,286	6.3%

Source: City of Salem; Strategic Economic Development Corporation (SEDCOR)

The following Table C-15 identifies the current labor force and industry employment in Salem metropolitan statistical area (MSA), and the changes that occurred between May 2022 and May 2023.

Table C-15 Salem MSA Current Labor Force and Industry Employment

	May 2023	April 2023	May 2022	--Change From-- April 2023	May 2022
Labor Force Status					
Civilian labor force	209,560	208,935	210,255	625	-695
Unemployed	6,669	6,013	7,285	656	-616
Unemployment rate	3.2%	2.9%	3.5%	0.3	-0.3
Unemployment rate (seasonally adjusted)	*3.8%*	*4.0%*	*3.9%*	*-0.2*	*-0.1*
Employed	202,891	202,922	202,970	-31	-79
Nonfarm Payroll Employment					
Total nonfarm employment	181,100	180,000	176,100	1,100	5,000
Total nonfarm employment (seasonally adjusted)	180,800	180,500	175,300	300	5,500
Total private	136,100	135,300	133,000	800	3,100
Mining and logging	700	600	600	100	100
Mining, logging, and construction	14,000	13,600	13,500	400	500
Construction	13,300	13,000	12,900	300	400
Manufacturing	11,600	11,500	12,000	100	-400
Durable goods	5,900	5,900	6,200	0	-300
Nondurable goods	5,700	5,600	5,800	100	-100
Food manufacturing	3,500	3,500	3,500	0	0
Trade, transportation, and utilities	29,800	29,600	30,400	200	-600
Wholesale trade	4,200	4,100	4,100	100	100
Retail trade	19,000	18,900	19,300	100	-300
Transportation, warehousing, and utilities	6,600	6,600	7,000	0	-400
Information	1,600	1,600	1,600	0	0
Financial activities	6,800	6,800	6,900	0	-100
Professional and business services	18,000	17,800	16,700	200	1,300
Administrative and support services	9,000	8,900	9,100	100	-100
Private education and health services	32,500	33,100	30,900	-600	1,600
Health care and social assistance	28,800	29,300	27,400	-500	1,400
Leisure and hospitality	16,000	15,500	15,600	500	400
Accommodation and food services	14,400	13,900	13,900	500	500
Other services	5,800	5,800	5,400	0	400
Government	45,000	44,700	43,100	300	1,900
Federal government	1,500	1,400	1,500	100	0
State government	22,400	22,400	21,400	0	1,000
State education	1,200	1,200	1,000	0	200
Local government	21,100	20,900	20,200	200	900
Indian tribal	1,500	1,500	1,500	0	0
Local education	12,600	12,500	12,200	100	400

The most recent month is preliminary, the prior month is revised. Prepared in cooperation with the U.S. Department of Labor, Bureau of Labor Statistics.

Civilian labor force includes employed and unemployed individuals 16 years and older by place of residence.
Employed includes payroll employment, self-employed, unpaid family workers, domestics, agriculture, and labor disputants.
Unemployment rate is calculated by dividing unemployed by civilian labor force.

Nonfarm Payroll Employment: Offical Oregon Series. Data are by place of work and cover full- and part-time employees who worked or received pay for the pay period that includes the 12th of the month. The data exclude the self-employed, volunteers, unpaid family workers, and domestics.

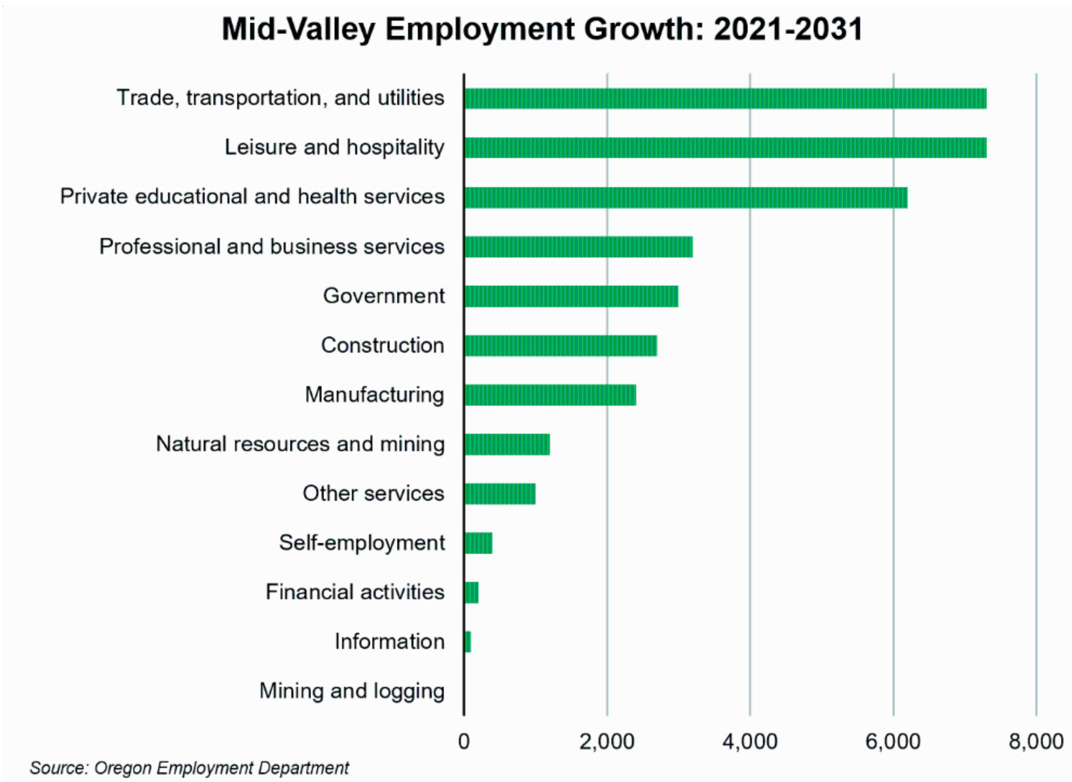
Source: O'Conner, 2023.

Future Employment in Industry

The Mid-Valley Workforce Area, which includes Marion and Polk Counties and the City of Salem, will add 35,000 jobs between 2021-2031, according to the Oregon Employment Department. This represents a 12% increase in employment over 10 years. However, this is slower than the 22% growth rate over the past decade in this region. The projected growth is derived from the anticipated private-sector gains of 31,600 jobs (15%) and an additional 3,000 jobs (6%) in government. There will be job growth in all the broad private-sector industries by 2031. (O'Connor, 2023) Some of these sectors often require more training and education, while others require less education and have lower wages.

Sectors that are anticipated to be major employers in the future also warrant special attention in the hazard mitigation planning process. As shown in Figure C-12, between 2021 and 2031, the largest employment growth is anticipated within the trade, transportation, and utilities sector (+7,300) and leisure and hospitality (+7,300). Another sector that is projected to grow is construction with 2,700 jobs (O'Connor, 2023). Lastly, the region's health care and social assistance sector is projected to grow 14% over the decade with 5,400 jobs.

Figure C-12 Mid-Valley Employment Growth: 2021-2031



Source: O'Connor, 2023

Synthesis

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. It is important to consider what might happen to the City of Salem, together with the Marion and Polk County, economy if some of the largest revenue generators and employers, were heavily impacted by a disaster. The city's economy is expected to grow by 2031, with much of the growth within the industries of trade, transportation, and utilities; leisure and hospitality; construction; and health care and social assistance industries. Areas with less income equality, particularly in the smaller cities, higher housing costs, and overall low economic diversity are factors that may contribute to slower recovery from a disaster.

Built Environment Capacity

Built Environment capacity refers to the built environment and infrastructure that supports the community. The various forms, quantity, and quality of built capital mentioned above contribute significantly to community resilience. Physical infrastructures, including utility and transportation lifelines, are critical 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.

Land Use and Development Patterns

One significant way in which Salem residents can increase or decrease their vulnerability to natural hazards is through development patterns. The way in which land is used – is it 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. Buildable lands within the Urban Growth Boundary (UGB) were intended to satisfy the demands of population and employment growth for a 20-year period. Follow this link for a map of Salem's current UGB: https://www.cityofsalem.net/home/showpublisheddocument/5162/637798389473130000

Regulatory Context

Oregon land use laws require land outside UGBs to be protected for farm, forest, and aggregate resource values. This law limits the amount of development in the rural areas. However, the land use designation can change from resource protection in one of two ways:

- The requested change could qualify as an exception to Statewide 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 and 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 on related topics, such as citizen involvement, land use planning, and natural resources.

Most of the goals are accompanied by "guidelines," which are suggestions about how a goal may be applied. Oregon's statewide goals are achieved through local comprehensive planning. State law requires each city and city to adopt a comprehensive plan and the zoning and land-division ordinances needed to put the plan into effect. The local comprehensive plans must be consistent with the statewide planning goals. Plans are reviewed for such consistency by the state's Land Conservation and Development Commission (LCDC). When LCDC officially approves a local government's plan, the plan is said to be "acknowledged." It then becomes the controlling document for land use in the area covered by that plan.

Oregon Statewide Planning Goal 7

The Oregon Statewide Planning Goal 7, Areas Subject to Natural Disasters and Hazards, has the overriding purpose to "protect people and property from natural hazards". Goal 7 requires local governments to adopt comprehensive plans (inventories, policies and implementing measures) to reduce risk to people and property from natural hazards. Natural hazards include floods, landslides, earthquakes, tsunamis, coastal erosion, and wildfires.

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 should 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 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 should coordinate their land use plans and decisions with emergency preparedness, response, recovery, and mitigation programs. Given the numerous waterways and forested lands throughout Corvallis, special attention should be given to problems associated with riverbank erosion and potential for wild land/urban interface fires.

Goal 7 guides local governments to give special attention to emergency access when considering development in identified hazard areas, including:

a) Consider programs to manage stormwater runoff to address flood and landslide hazards,
b) Consider non-regulatory approaches to help implement the goal,
c) 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.
d) Consider measures exceeding the National Flood Insurance Program.

Changes in Development

Since the *2017 Salem NHMP*, the city has seen continued growth. Development has taken place across Salem, including new multifamily residential projects, low-density subdivisions, and commercial development. Certain natural hazards pose citywide impacts. These include earthquakes, extreme heat, drought, air quality hazards, windstorms, and winter storms. Salem also has numerous waterways that pose a flood hazard in pockets around the city.

Most vacant land allocated for residential development in Salem's portion of the urban growth boundary is in South and West Salem, and a great deal of development has taken place in these areas since the *2017 Salem NHMP* was published. South and West Salem have more hills than other parts of the city, which makes these areas more susceptible to landslides. Additionally, because these areas are closer to the edge of the Salem urban area and tend to have more tree and vegetation cover, they are also potentially more vulnerable to wildfires.

Salem has also seen new development in its downtown area, which allows taller, denser buildings relative to other parts of the city. Multiple waterways, including the Willamette River, Pringle Creek, and Mill Creek flow close to downtown. Limited parts of Salem's downtown area lie within the 100-year floodplain, making flooding is a potential risk in these areas, especially if the intensity of floods increases in a climate-altered future.

Since 2017, new industrial development has been primarily located in southeast Salem in areas like the Mill Creek Corporate Center. Flooding presents a potential hazard in this area. However, a stormwater management plan was developed to treat and direct stormwater to the central and south open space wetland areas. New development is required to work with the stormwater plan. The wetlands and channels have been constructed and the development property closest to Mill Creek has been filled and elevated outside the floodplain where FEMA has issued a Letter of Map Amendment showing the property above the floodplain. Other industrial development has taken place in the North Gateway area near Portland Road NE. This area is not susceptible to any unique natural hazards.

Salem's parks system has also been expanded since 2017, with park development and improvements being made to several parks in the city. This development includes recent upgrades to Geer Park, Secor Park, Riverfront Park, and Woodmansee Park. Many of these upgrades included green infrastructure to help improve resiliency and help mitigate hazards like extreme heat and flooding.

The Salem Area Comprehensive Plan (SACP) was updated in 2022, and it anticipates continued growth in the Salem Urban Area. The updated SACP, along with changes to Salem's Zoning Map and Comprehensive Plan Map, encourages infill development and redevelopment, especially mixed-use development in and around downtown and along Salem's major transit corridors. Additionally, pockets of undeveloped land in South and West Salem were rezoned for mixed-use development, and more land for multifamily housing was distributed across the city. The updated SACP also contains goals and policies related to natural hazard mitigation and resilience, which align with this plan, and help to minimize risks from natural hazards to future development.

Housing

In addition to location, the characteristics of the housing stock affect the level of risk posed by natural hazards. The table below identifies the types of housing most common throughout the city. Of interest are mobile homes and other non-permanent residential structures, which account for 4.2% of the housing in Salem. These structures are particularly vulnerable to certain natural hazards, such as windstorms, and special attention should be given to securing the structures, because they are more prone to wind damage than wood-frame construction. In other natural hazard events, such as earthquakes and floods, these structures are more likely to shift on their foundations and create hazardous conditions for occupants.

Table C-16 Housing Profile

Units in Structure	Estimate	%
1-unit, Single-family (detached)	40,706	58.8%
1-unit, Single-family (attached)	3,097	4.5%
2 units	2,195	3.2%
3 or 4 units	3,490	5.0%
5 to 9 units	6,749	9.7%
10 to 19 units	3,826	5.5%
20 or more units	6,066	8.8%
Mobile home	2,902	4.2%
Boat, RV, van, etc.	216	0.2%
Total housing units	69,247	--

Source: U.S. Census, 2021

Aside from location and type of housing, the year structures were built has implications. Seismic building standards were codified in Oregon building code starting in 1974 more rigorous building code standards were passed in 1993 that accounted for the Cascadia earthquake fault (Oregon Building Codes Division, 2012). Therefore, homes built before 1993 are more vulnerable to seismic events. Also, in the 1970's, FEMA began assisting communities with floodplain mapping as a response to administer the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps (locally 1979), communities started to develop floodplain management ordinances to protect people and property from flood loss and damage.

Based on U.S. Census data, approximately two-thirds of the residential housing in Salem was built before the current seismic building standards of 1990 and Approximately 54% of residential structures were constructed prior to the local implementation of the flood elevation requirements of the 1970's (city Firms-were not completed until 1979).

Table C-17 Year Structure Built

Year Structure Built	Estimate	%
Built 2020 or later	678	1.0%
Built 2010 to 2019	5,621	8.1%
Built 2000 to 2009	8,982	13.0%
Built 1990 to 1999	9,020	13.0%
Built 1980 to 1989	7,219	10.4%
Built 1970 to 1979	12,162	17.6%
Built 1960 to 1969	7,996	11.5%
Built 1950 to 1959	7159	10.3%
Built 1940 to 1949	3,895	5.6%
Built 1939 or earlier	6,515	9.4%
Total housing units	69,247	--

Source: U.S. Census Bureau, 2021

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage minimized. City of Salem is in Marion and Polk Counties. Depending on what part of the city, FIRM panels were issued January 19, 2000, January 2, 2003, or October 18, 2019. The table below shows the number of buildings in the floodplain based on zoning designation. For more information about the flood hazard, NFIP, and FIRMs, please refer to Flood Hazard section of the Risk Assessment.

Table C-18 Number of Buildings in the Floodplain by Zoning Designation

Number of Buildings in the Floodplain by Zoning Designation	
Zoning Designation	**Number of Buildings**
Critical Facilities (All Zones)	14
Commercial	274
Industrial	364
Public	120
Residential	2,417
Mixed Use	1
TOTAL	**3,190**

Source: City of Salem, 2018

Critical Facilities

Critical Facilities include buildings, their internal components and trained personnel, and may also include certain mobile units, such as those of first responders. For example, many vehicles of the police department, fire department (including ambulances), and public works department are key and essential components of the functions provided by these critical facilities. The interruption or destruction of any of these facilities would have a debilitating effect on incident management and long-term recovery. Not all Critical Facilities are of equal importance and are therefore subject to prioritization of criticality.

While lifelines and other physical infrastructure, such as, dams, power generation facilities and transmission lines, are also critical, they have been documented under physical infrastructure and utility lifelines for the purposes of this profile. This information provides the basis for informed decisions about the infrastructure and facilities already in place that can be used to reduce the vulnerability of Salem to natural hazards.

The NHMP identifies critical facilities in Table C-19 below (see also Figure C-13) following the priority ranking system utilized in the Salem LEAP (2012). This ranking system draws inspiration from Horry County, South Carolina, and incorporates the concept of Maximum Allowable Down Time (MAD Time). The top three priority lists are listed in descending order of importance.

- **Priority One** - Critical Facilities and Critical Infrastructure: These facilities and assets are of utmost importance as the loss of energy supply, even for a short duration, can have severe adverse effects on human life, health, safety, and the surrounding environment, particularly critical community assets. They are vital in emergency response and recovery efforts, necessitating a continuous energy supply to sustain their functions. Emergency response plans must incorporate measures to ensure that these Priority One Facilities and Infrastructure promptly regain a reliable and sufficient energy source following an energy disruption.
- **Priority Two** - Critical Facilities and Critical Infrastructure: Extended loss of energy supply, exceeding 24 hours, to these facilities and assets, could result in significant negative impacts on human life, health, safety, and the built environment,

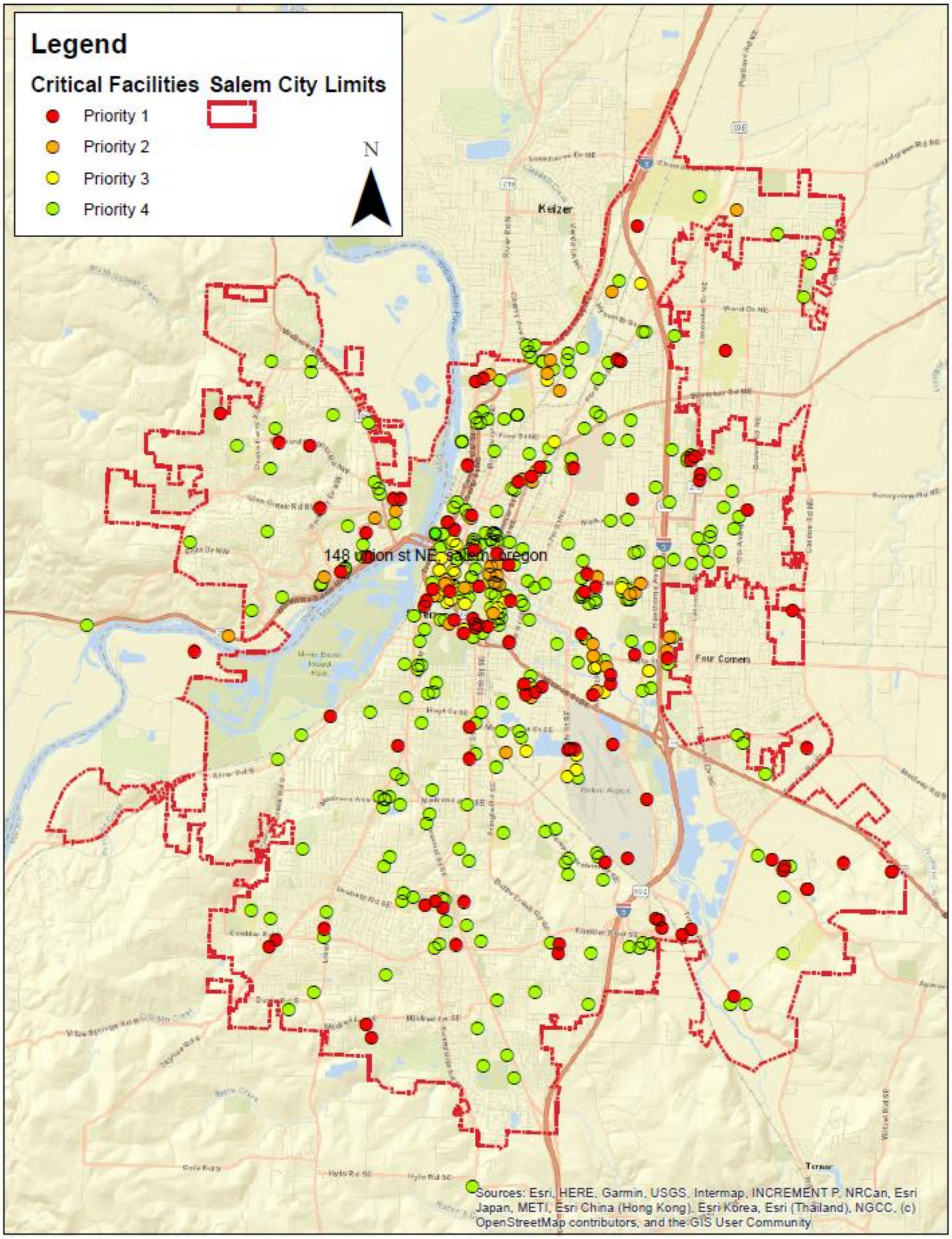
particularly critical community assets. Emergency response plans should outline strategies to secure a stable energy source for these Priority Two Facilities and Infrastructure once the Priority One Facilities and Infrastructure have been restored, as feasible within the nature of the emergency event.

- **Priority Three** - Critical Facilities and Critical Infrastructure: If the energy supply to these facilities and assets is interrupted for more than 72 hours, it could have substantial adverse effects on human life, health, safety, and the built environment, especially critical community assets. They play a crucial role in disaster recovery efforts and require an energy supply to maintain their functions. However, the supply may not need to be at normal levels or uninterrupted. Emergency response plans must include measures to procure suitable energy for these facilities and infrastructure, considering the nature of the emergency event and the capacity of response and recovery teams to meet the energy needs of as many higher-priority Critical Facilities and Infrastructure as possible.
- **Priority Four** - Other Priority Critical Facilities and Infrastructure: This category, determined in coordination with the city and emergency operation centers, should encompass facilities such as Nursing Homes, Critical Care Facilities, Special Needs Services, Senior Centers, and operational schools. It should also contain additional designated City of Salem Public Works Facilities and Infrastructure (e.g., water and sewage).

During the risk assessment conducted by the Steering Committee, the group identified several critical facilities, essential facilities, public infrastructure, and social service facilities considered critical. The Steering Committee greatly expanded the critical facilities list since the *2017 Salem NHMP*. Table C-19, and shown in Figure C-13, identifies these facilities. Some critical facilities are also identified above in the Hazard Identification and Assessment section, either listed by name or simply noted the number of critical facilities that will be affected by a specific hazard event.

Salem is also unique in that there are numerous state-owned government buildings throughout the city, some of which are listed below in Table C-19. These buildings are essential to government continuity throughout the entire state and should be included as critical infrastructure. It is essential that Salem recognize their importance; however, the city does not necessarily have control over them.

Figure C-13 Salem Critical Facilities



Source: City of Salem

Table C-19 Salem Critical Facilities

Facility Name	Property Use	Facility Priority
Communications		
AT&T Cell Tower Generator	Utility or Distribution system- other	1
AT&T Cell Tower Generator Building	Outbuilding or shed	1
Cctv Studio	Radio- television studio	1
KCCS Radio Tower	Mercantile- business- other	1
OSP Radio Shop	Mercantile- business- other	1
State of Oregon - Data Center (ETS)	Business office	1
Verizon Cell Tower	Property Use- other	1
AT&T Cell Tower @ Mission Mill	Utility or Distribution system- other	2
CenturyLink	Communications center	2
Salem Clinic - Call Center	Communications center	2
United States Postal Services - Bldg. Shell	Post office or mailing firms	2
US Post office	Mercantile- business- other	2
US Post office	Post office or mailing firms	2
West Salem Post office	Post office or mailing firms	2
Vista Post office	Post office or mailing firms	4
Emergency Coordination / Communication		
Anderson Readiness Center	Undetermined	1
Willamette Valley Communication Center	Public or government- other	1
Emergency Response		
Bureau of Criminal Id.	Mercantile- business- other	1
City of Salem - Sand Storage	Undetermined	1
City of Salem Public Works Operations	Public or government- other	1
Falck office/Warehouse - Bldg. Shell	Undetermined	1
Fire Sta. # 9	Fire station	1
Fire Station # 7	Fire station	1
Fire Station #1	Fire station	1
Fire Station #10	Fire station	1
Fire Station #2	Fire station	1
Fire Station #3	Fire station	1
Fire Station #8	Fire station	1
Marion County Maint. Shop	Mercantile- business- other	1
Marion County Public Works Fuel Tank	Service station- gas station	1
Marion County Sherriff's office	Business office	1
Modular Scenario Bldg..	Police station	1
Oregon Dept. Emergency Management & ODOT	Manufacturing- processing	1
Oregon Dept. Environmental Quality	Mercantile- business- other	1
Oregon National Guard Military HQ	Defense- military installation	1
Oregon National Guard Open Hanger- Hanger 2- Hanger 3- Flight Ops	Defense- military installation	1
Oregon State Forestry - Hanger	Storage- other	1
Oregon State Police	Mercantile- business- other	1
Oregon State Police Headquarters	Business office	1
OSP Fleet Services	Police station	1
OPS Installation Center	Mercantile- business- other	1
OSP Vehicle Storage	Parking garage- general vehicle	1
Salem Fire Station 11	Fire station	1
Salem Fire Ems office	Mercantile- business- other	1

Facility Name	Property Use	Facility Priority
Salem Fire Station 5	Fire station	1
Salem Police Department	Police station	1
Salem Fire Station 4	Fire station	1
Salem Fire Station 6	Fire station	1
Board of Parole & Post-Prison Supervision	Business office	2
Oregon Dept. of Corrections Fuel Island	Mercantile- business- other	2
OSP Storage	Storage- other	2
Police & Weighmaster 8	Mercantile- business- other	2
DPSST - Program Services/Multi-Purpose	Public or government- other	3
DPSST - Skills Bldg..	Public or government- other	3
DPSST - Tactical Training Facility	Street- other	3
Energy		
BPA Salem Substation	Electrical distribution	2
Comcast - Electrical Bldg.	Electrical distribution	2
NW Natural	Mercantile- business- other	2
PGE	Electrical distribution	2
PGE Energy Storage Facility	Energy production plant- other	2
Portland General Electric	Mercantile- business- other	2
Salem Electric	Mercantile- business- other	2
Governance		
City Hall / Civic Center	Undetermined	1
City of Salem	Business office	1
City of Salem	Fixed-use recreation places- other	1
City of Salem It Department	Undetermined	1
State Capitol Bldg.	Assembly- other	1
Department of Energy	Business office	2
Marion County Juvenile Pro.	Mercantile- business- other	2
Oregon Municipal Electric Utilities	Mercantile- business- other	2
Revenue Building	Mercantile- business- other	2
State of Oregon Central Computer Facility	Computer center	2
State of Oregon Dept. of Justice	Business office	2
State of Oregon Dept. of Justice	Business office	2
Transfer/Recycle Station	Mercantile- business- other	2
Department of Human Services	Business office	3
Department of Justice	Mercantile- business- other	3
Marion County Juvenile Administration office	Business office	3
Mid-Willamette Valley Council of Governments	Mercantile- business- other	3
National Weather Service	Electric-generating plant	3
Oregon Judicial Dept/ It Division	Mercantile- business- other	3
Oregon Judicial Department	Mercantile- business- other	3
Oregon Judicial Department West	Undetermined	3
Oregon Judicial Department East	Undetermined	3
Oregon State Judicial Department	Business office	3
State of Oregon	Mercantile- business- other	3
Oregon State Court Adm	Warehouse	3
Assoc. of Comm. Mental Health Program	Mercantile- business- other	4
Bureau of Labor and Industries	Mercantile- business- other	4
Bureau of Land Mgmt	Mercantile- business- other	4
Department of Human Resources	Mercantile- business- other	4

Facility Name	Property Use	Facility Priority
Department of Human Services	Mercantile- business- other	4
Department of Justice	Mercantile- business- other	4
Department of Motor Vehicles (DMV)	Business office	4
Department of Ag Modular	Business office	4
Department of Ag Plant Division	Mercantile- business- other	4
Department of Agriculture	Mercantile- business- other	4
Department of Motor Vehicles	Mercantile- business- other	4
DEQ	Business office	4
DHS Community Resources	Mercantile- business- other	4
DHS OHP SSP Division	Business office	4
DHS/APD/HCC	Business office	4
DHS/OHA	Business office	4
DHS-Salem	Mercantile- business- other	4
DHS-State of Oregon - Bldg. Shell	Business office	4
Interim Healthcare of Oregon	office: veterinary or research	4
Labor & Industries	Mercantile- business- other	4
Labor & Industries - Bldg. Shell	Undetermined	4
Liberty Square Parking	Parking garage- general vehicle	4
Marion County Assessor office	Business office	4
Marion County Association of Defenders	Business office	4
Marion County Environmental Health	Mercantile- business- other	4
Marion County Health Department	Mercantile- business- other	4
Marion County Managed Care	Post office or mailing firms	4
Marion Polk Bldg. Industry Association	Mercantile- business- other	4
Marion Polk Legal Aid	Mercantile- business- other	4
Marion Polk Med. Society	Mercantile- business- other	4
Occupational Health & Safety Division	Business office	4
OR State Hwy Weighmastrs	Mercantile- business- other	4
OR State Council for Seniors	Mercantile- business- other	4
Oregon Dept. Administrative Services	Mercantile- business- other	4
Oregon Dept. of Fish and Wildlife	Business office	4
Oregon Dept. of Human Services	Mercantile- business- other	4
Oregon Dept. of Human Services	Business office	4
Oregon Dept. of Human Services-Facilities	Storage- other	4
Oregon Employment Dept.	Business office	4
Oregon Judicial	Mercantile- business- other	4
Oregon School Board Association	Mercantile- business- other	4
Oregon State Archives	Ind.- utility- defense- agriculture- mining- other	4
Oregon State Forestry	Mercantile- business- other	4
Oregon State Forestry	Mercantile- business- other	4
Oregon State Forestry	Mercantile- business- other	4
Oregon State Grange	Mercantile- business- other	4
Oregon State Marine Board	Mercantile- business- other	4
Oregon State Supreme Court	Business office	4
Public Works Warehouse	Parking garage- general vehicle	4
Salem-Keizer Public Schools	Parking garage- general vehicle	4
Social Security office	Mercantile- business- other	4
State Board Arch. Exam	Mercantile- business- other	4
State Building Codes - A	Mercantile- business- other	4

Facility Name	Property Use	Facility Priority
State Building Codes - B	Mercantile- business- other	4
State Building Codes - C	Mercantile- business- other	4
State of OR Lands Div.	Mercantile- business- other	4
State of Oregon	Business office	4
State of Oregon - Bldg. Shell	Business office	4
State of Oregon - Bldg. Shell	Business office	4
State of Oregon - DHS/OHA	Storage- other	4
State of Oregon - Public Service Bldg..	Mercantile- business- other	4
State of Oregon - Stiff -Jarmen House	Business office	4
State of Oregon (Consumer & Business Ser	Warehouse	4
State of Oregon Employee Relation Board	Mercantile- business- other	4
State of Oregon Ford House - Bldg. Shell	Business office	4
State of Oregon Library - Bldg. Shell	Undetermined	4
State of Oregon/Employmt	Storage- other	4
Willamette University Carnegie	Mercantile- business- other	4
Willamette University Legal Arts	Mercantile- business- other	4
Mass Care and Shelter		
State of Oregon Dept. of Corrections	Jail- prison (not juvenile)	1
Abioua Middle School	High school/junior high school/middle school	4
Alice Yoshikai Elementary School	Elementary school- including kindergarten	4
Avamere- Bldg. Shell	Elementary school- including kindergarten	4
Baker School	Elementary school- including kindergarten	4
Battle Creek Elementary	Elementary school- including kindergarten	4
Boone Rd Fuel Tank	Public or government- other	4
Brush College Elementary	Elementary school- including kindergarten	4
Bush Elem School	Elementary school- including kindergarten	4
Capitol Christian School	Elementary school- including kindergarten	4
Career Technical Educational Center-SKSD	High school/junior high school/middle school	4
Cep office Building - Bldg. Shell	Public or government- other	4
Chapman Hill Elementary	Elementary school- including kindergarten	4
Chemawa Indian School	High school/junior high school/middle school	4
Columbia Hall	Convention center- exhibition hall	4
Convention Center - Bldg. Shell	Convention center- exhibition hall	4
Corban University	Educational- other	4
Crossler Middle School	Educational- other	4
Department of Business & Cons. Services - Bldg.	Public or government- other	4
Dept. of Corrections	Undetermined	4
Dept. of Forestry - Fire Cache	Warehouse	4
Dept. of Motor Vehicles	Manufacturing- processing	4
DPSST - Academic-Classrooms & office	Public or government- other	4
Dyehouse	Public or government- other	4

Facility Name	Property Use	Facility Priority
Eagle Charter School	Elementary school- including kindergarten	4
Elementary School	Elementary school- including kindergarten	4
Englewood School	Elementary school- including kindergarten	4
Environmental Learning Center - North Sa	High school/junior high school/middle school	4
Faye Wright Elementary School	Elementary school- including kindergarten	4
Grant School	Elementary school- including kindergarten	4
Hammond Elementary School	Elementary school- including kindergarten	4
High School	High school/junior high school/middle school	4
Highland Elementary School	Elementary school- including kindergarten	4
Hillcrest School - School Building	Undetermined	4
Hoover School	Elementary school- including kindergarten	4
Houck Middle School	Educational- other	4
Howard St School	Educational- other	4
Howard Street Charter School	High school/junior high school/middle school	4
Immanuel Elementary School	Educational- other	4
Internal Revenue Service	Public or government- other	4
Jackman-Long Building	Convention center- exhibition hall	4
Jesse M. Harritt Elementary	Elementary school- including kindergarten	4
Joint Forces Headquarters	Defense- military installation	4
Judson Middle School	High school/junior high school/middle school	4
Lee Elementary School	Elementary school- including kindergarten	4
Leslie Middle School	Educational- other	4
Liberty School -Main Building	Elementary school- including kindergarten	4
Marion County Courthouse	Courthouse	4
Marion County Health Department	Undetermined	4
Marion County Historical	Public or government- other	4
Marion County Jail	Jail- prison (not juvenile)	4
McKay High School	High school/junior high school/middle school	4
McKinley School	Elementary school- including kindergarten	4
Meyers Elementary School	Elementary school- including kindergarten	4
Middle School	High school/junior high school/middle school	4
Miller Elementary School	Elementary school- including kindergarten	4
Montessori Children House	Schools- non-adult- other	4

Facility Name	Property Use	Facility Priority
Morningside School	Elementary school- including kindergarten	4
North Salem High	High school/junior high school/middle school	4
ODOT Traffic Signal	Warehouse	4
Office of the State Chief Information officer	Public or government- other	4
Old Pringle School House	Elementary school- including kindergarten	4
OR Dept. General Services Warehouse	Warehouse	4
OR Dept. of Human Services	Manufacturing- processing	4
OR Dept. of Corrections- Metal Fab	Manufacturing- processing	4
OR School for Blind-Irvine Hall	High school/junior high school/middle school	4
Oregon Center for Clinical Investigation	Laboratory or science laboratory	4
Oregon Dept. of Transportation	Manufacturing- processing	4
Oregon Judicial Department - Human Resources Services Division	Public or government- other	4
Oregon State Archives	Warehouse	4
Oregon State Lottery	Public or government- other	4
Parrish Middle School	High school/junior high school/middle school	4
Pringle School	Elementary school- including kindergarten	4
Public Work/Carpenter	Warehouse	4
Queen of Peace School	Elementary school- including kindergarten	4
Richmond School	Elementary school- including kindergarten	4
Riviera Christian School & Daycare	Elementary school- including kindergarten	4
Roberts High School (Alt Ed)	High school/junior high school/middle school	4
Roots Academy	High school/junior high school/middle school	4
S.E.C. Modular #2	Elementary school- including kindergarten	4
Salem Academy High School	High school/junior high school/middle school	4
Salem Academy-Elementary	Elementary school- including kindergarten	4
Salem Armory Auditorium	Convention center- exhibition hall	4
Salem Christian Academy	Elementary school- including kindergarten	4
Salem Clinic	Warehouse	4
Salem Heights School	Elementary school- including kindergarten	4
Salem Keizer School District	Educational	4
Salem Reserve Center Modular	Defense- military installation	4
Salem Senior Center (Center 50+)	Assembly- other	4
Santiam Correctional Facility	Jail- prison (not juvenile)	4
Schirle School	Elementary school- including kindergarten	4

Facility Name	Property Use	Facility Priority
South Salem High School	High school/junior high school/middle school	4
South Salem Senior Center	Public or government- other	4
Sprague High School	High school/junior high school/middle school	4
St John’s Lutheran School	Day care- in commercial property	4
St Joseph's Elementary School	Educational- other	4
St Vincent De Paul School	Elementary school- including kindergarten	4
Stephens Middle School	High school/junior high school/middle school	4
Straub Middle School	High school/junior high school/middle school	4
Sumpter School	Elementary school- including kindergarten	4
Supreme Court Building	Public or government- other	4
Swegle Elementary School	Elementary school- including kindergarten	4
Tokyo International University	Educational- other	4
U.S. Dept. of Agriculture	Warehouse	4
Waldo Middle School	High school/junior high school/middle school	4
Walker Middle School	Elementary school- including kindergarten	4
Washington School	Elementary school- including kindergarten	4
West Salem Foursquare School	Elementary school- including kindergarten	4
West Salem High School	High school/junior high school/middle school	4
Wildfire Defense Systems	Warehouse	4
Willamette Academy- College Prep	High school/junior high school/middle school	4
Willamette Career Academy	High school/junior high school/middle school	4
Willamette University	Mercantile- business- other	4
Medical		
Kaiser Permanente	Clinics- doctors offices- hemodialysis cntr- other	1
Kaiser Permanente Dental	office: veterinary or research	1
Kaiser Permanente Medical	Clinics- doctors offices- hemodialysis cntr- other	1
Kaiser Skyline Clinic	Clinics- doctors offices- hemodialysis cntr- other	1
Marion County Dog Control	office: veterinary or research	1
Marion County Health & Human Services - Psychiatric Crisis Center	Hospital - medical or psychiatric	1
Northbank Surgical Center	Clinic- clinic-type infirmary	1
OR State Hospital Cottage R-02	Residential board and care	1
Oregon State Hospital	Hospital - medical or psychiatric	1
Oregon State Prison	Clinic- clinic-type infirmary	1
Permanente (Kaiser) Dental (Skylne)	Doctor- dentist or oral surgeon office	1
Psychiatric Facility	Hospital - medical or psychiatric	1

Facility Name	Property Use	Facility Priority
Rehabilitation Center	Hospital - medical or psychiatric	1
Salem Audiology Clinic	office: veterinary or research	1
Salem Clinic P.C.	Clinics- doctors offices- hemodialysis cntr- other	1
Salem Clinic P.C.	Health care- detention- & correction- other	1
Salem Clinic South - Bldg. Shell	Clinics- doctors offices- hemodialysis cntr- other	1
Salem Hospital	Hospital - medical or psychiatric	1
Salem Hospital	Mercantile- business- other	1
Salem Hospital/MRI Center	Clinics- doctors offices- hemodialysis cntr- other	1
Salem V.A. Clinic	Clinics- doctors offices- hemodialysis cntr- other	1
Urgent Care - Salem Hospital	Doctor- dentist or oral surgeon office	1
West Salem Clinic Mental clinic	Health care- detention- & correction- other	1
West Salem Family Medical Clinic	Doctor- dentist or oral surgeon office	1
Willamette Surgery Center	Hospital - medical or psychiatric	1
Willamette Urology Clinic - Bldg. Shell	Clinic- clinic-type infirmary	1
Work Release Center	Health care- detention- & correction- other	1
Marion County Health Department	Business office	2
Marion County Health Stor	Mercantile- business- other	2
Polk County Mental Health	Clinics- doctors offices- hemodialysis cntr- other	2
Salem Clinic Annex	Clinics- doctors offices- hemodialysis cntr- other	2
Salem Health Admin offices	Business office	2
ATI Physical Therapy	Clinics- doctors offices- hemodialysis cntr- other	4
Center for Medicare	Business office	4
Department of Veteran Affairs	Clinics- doctors offices- hemodialysis cntr- other	4
InterState Medical Group	Clinics- doctors offices- hemodialysis cntr- other	4
Marion County Gap House	Business office	4
Option Counseling and Family Services	Clinics- doctors offices- hemodialysis cntr- other	4
Portland DBT Institute	Clinics- doctors offices- hemodialysis cntr- other	4
Salem Health Outpatient Rehab Bldg. M	Clinics- doctors offices- hemodialysis cntr- other	4
Salem Hospital-Marketing	Mercantile- business- other	4
State Dental Lab	Mercantile- business- other	4
Willamette Valley Dental Assistant School	office: veterinary or research	4
Willamette Valley Eye Center	Clinics- doctors offices- hemodialysis cntr- other	4
Miscellaneous		
Marion County Housing Authority	Undetermined	3
Salem Housing Authority		3
School District 24J Reprographics	Warehouse	3

Facility Name	Property Use	Facility Priority
FACES of America DBA Family Literacy & Resource Center	Schools- non-adult- other	4
Howard Street Charter School Dance Studio	Educational	4
Little Bird Childcare	Preschool	4
Special Needs		
Department of Corrections-Dome Building	Business office	2
Oregon Dept. of Corrections	Storage- other	2
Dept. of Corrections	Mercantile- business- other	3
Assisted Living - Bldg. Shell	Undetermined	4
Battle Creek Memory Care	24-hour care Nursing homes- 4 or more persons	4
Bonaventure	Residential board and care	4
Boone Ridge Senior Living Community	24-hour care Nursing homes- 4 or more persons	4
Bridgeway Recovery	Health Care- Detention & Correction	4
Brookdale Senior Living	24-hour care Nursing homes- 4 or more persons	4
Brookstone Alzheimer Special Care Center	Health care- detention- & correction- other	4
Capitol Manor Health Care Complex	24-hour care Nursing homes- 4 or more persons	4
Care Takers House - Bldg. Shell	1 or 2 family dwelling	4
Carroll's Group Care Home	Residential board and care	4
CCPC Group Home (Licensed)	Residential board and care	4
Center for Autism & Related Disorders (CARD)	Mental retardation/development disability facility	4
Court St House	Health care- detention- & correction- other	4
Davita Salem Dialysis	Clinics- doctors offices- hemodialysis cntr- other	4
Day Care - Bldg. Shell	Day care- in commercial property	4
Developmental Disability Services - IDD Services	Mental retardation/development disability facility	4
Englewood East	Health care- detention- & correction- other	4
Family Hd Start Pr School	Mental retardation/development disability facility	4
Faye Wright Square Building #1	24-hour care Nursing homes- 4 or more persons	4
Firehouse Diabetes & Endocrine Center	Doctor- dentist or oral surgeon office	4
Fmc- D.S. of West Salem	Hemodialysis unit	4
Gibson Creek Assisted Living Residence	Residential board and care	4
Great Circle Recovery	Alcohol or substance abuse recovery center	4
Harmony House	Health care- detention- & correction- other	4
Harmony House of Salem	Residential board and care	4
Harmony Manor	Health care- detention- & correction- other	4
Hawthorne House of Salem	24-hour care Nursing homes- 4 or more persons	4
Hidden Lakes Retirement Residences	Mental retardation/development disability facility	4

Facility Name	Property Use	Facility Priority
Immed Care & Med Clinic	Health care- detention- & correction- other	4
Iuditas' Memory Care	24-hour care Nursing homes- 4 or more persons	4
Juvenile Department	Hemodialysis unit	4
Juvenile Probation	Health care- detention- & correction- other	4
Kairos NW - Cadenza	24-hour care Nursing homes- 4 or more persons	4
Kroc Center RJ's Preschool	Preschool	4
Kuebler Early Learning Center	Preschool	4
Lds Church Classroom	Schools- non-adult- other	4
Little Bird Preschool	Preschool	4
Little Me Academy	Preschool	4
Little Red Schoolhouse	Day care- in commercial property	4
Madrona Hills Ret Ctr	Health care- detention- & correction- other	4
Mainstream Housing	Health care- detention- & correction- other	4
Marion & Polk Healthy Start	Health care- detention- & correction- other	4
Marion County Alcohol & Drug Treatment	Mercantile- business- other	4
Marion County Dog Control	Health care- detention- & correction- other	4
Marion County Health & Human Services - Adult Behavioral Health	Residential board and care	4
Marion County Health & Human Services - Adult Mental Health	Clinics- doctors offices- hemodialysis cntr- other	4
Marion County Health and Human Service - Horizon House	Residential board and care	4
Marion County Health & Human Services - Adult Behavioral Health	Residential board and care	4
Marion County Juv. Dept- Boys Gap Program	Health care- detention- & correction- other	4
Marion County Juvenile Detention	Reformatory- juvenile detention center	4
Marion County Juvenile- Girls Gap Program	Health care- detention- & correction- other	4
Meadow Creek Village	Health care- detention- & correction- other	4
Mid-Willamette Valley Hospice	Residential board and care	4
Monica Custer Care Home	Health care- detention- & correction- other	4
Neil Carroll Group Home	Residential board and care	4
Northwest Human Services	Clinics- doctors offices- hemodialysis cntr- other	4
Northwest Rehabilitation Associates- Inc	Clinics- doctors offices- hemodialysis cntr- other	4
NW Human Services - West Salem Clinic Mental Health	Clinics- doctors offices- hemodialysis cntr- other	4
Oregon Medical Centers- LLC dba First Choice Chiropractic and Rehabilitation	Clinics- doctors offices- hemodialysis cntr- other	4
Pacific Cardiovascular Surgical Center	Clinics- doctors offices- hemodialysis cntr- other	4

Facility Name	Property Use	Facility Priority
Pheasant Hill-Labor 27	Health care- detention- & correction- other	4
Prestige Senior Living at Orchard Height	Residential board and care	4
Psychiatric Crisis Center (Marion County Health & Human Services)	Residential board and care	4
Records Storage	Health care- detention- & correction- other	4
Redwood Crossing Residential Care & Shelter Facility	Residential board and care	4
Redwood Heights Assisted Living	Health care- detention- & correction- other	4
Regency Woodland	24-hour care Nursing homes- 4 or more persons	4
Seed of Faith Ministries	Residential board and care	4
Seniors Care Sweet Home	24-hour care Nursing homes- 4 or more persons	4
Serenity Lane Treatment Center	Alcohol or substance abuse recovery center	4
Sherman Manor	Health care- detention- & correction- other	4
Simonka House	Health care- detention- & correction- other	4
Skilled Nursing - Bldg. Shell	24-hour care Nursing homes- 4 or more persons	4
So. Salem Rehabilitation	24-hour care Nursing homes- 4 or more persons	4
Substation Sheriff office	Health care- detention- & correction- other	4
Sunny Manor Inc	Health care- detention- & correction- other	4
Sunnyglen Retirement	Health care- detention- & correction- other	4
Sweet Bye & Bye - Coral Springs	Residential board and care	4
Sweet Bye N Bye	24-hour care Nursing homes- 4 or more persons	4
Team Bailey Inc	Residential board and care	4
The Springs at Willowcreek	Health care- detention- & correction- other	4
The Sweet Bye N Bye - Reflections Memory Care	Residential board and care	4
Tierra Rose Care Center	24-hour care Nursing homes- 4 or more persons	4
Union Gospel Mission of Salem	Residential board and care	4
Valley Mental Health	Clinics- doctors offices- hemodialysis cntr- other	4
Via Verde - Cottage 15	Asylum- mental institution	4
Vickie Harbaugh House	Residential board and care	4
Vida Integrative Medicine & Mental Health	Clinics- doctors offices- hemodialysis cntr- other	4
West Salem Prof Center	Health care- detention- & correction- other	4
Whitewood Gardens of Salem	24-hour care Nursing homes- 4 or more persons	4
Willamette Valley Community Action Agenc	office: veterinary or research	4
Willamette Valley Hospice	Mercantile- business- other	4

Facility Name	Property Use	Facility Priority
WindSong at Eola Hills Memory Care	24-hour care Nursing homes- 4 or more persons	4
Windsor Health & Rehabilitation Center	Health care- detention- & correction- other	4
Women at The Well Grace House	Residential board and care	4
Work Unlimited	Mental retardation/development disability facility	4
Transportation		
ODOT	Warehouse	1
Oregon Department of Transportation	Public or government- other	1
Oregon Dept. of Transportation	Rapid transit station	1
Sequential Bio Fuels Tank Farm	Flammable liquid distribution- F.L. pipeline	1
Sequential-Pacific Biodiesel	Flammable liquid distribution- F.L. pipeline	1
Department of Transportation	Mercantile- business- other	2
ODOT	Mental retardation/development disability facility	2
ODOT	Mercantile- business- other	2
ODOT Environmental	Mercantile- business- other	2
ODOT Transportation Bldg.	Mercantile- business- other	2
Oregon State Motor Pool	Mercantile- business- other	2
Transit off/Drivers Disp.	Mercantile- business- other	2
Airport Passenger Terminal- Tower	Undetermined	3
Chemeketa Parking Structure	Parking garage- general vehicle	3
Courthouse Square	Parking garage- general vehicle	3
Greyhound	Passenger terminal- other	3
Hospital Parking Garage	Parking garage- general vehicle	3
Liberty Square Parking	Parking garage- general vehicle	3
Library Parking	Parking garage- general vehicle	3
Marion St Parking Struct	Parking garage- general vehicle	3
ODOT Building X	Undetermined	3
ODOT Modular office	Business office	3
Pringle Parking Structure	Parking garage- general vehicle	3
Salem Transit	Mercantile- business- other	3
Salem Aviation Fueling - Bulk Storage	Parking garage- general vehicle	3
State Highway Division	Undetermined	3
State of Oregon Motor Pool	Mercantile- business- other	3
Transit Mall	Bus station	3
ODOT Building K	Business office	4
ODOT Geometrtonics	Mercantile- business- other	4
ODOT-Research	Mercantile- business- other	4
Ore State Aeronautic Div	Mercantile- business- other	4
Valley Oil Company	Mercantile- business- other	4
Water		
City Aquifer/Storage	Water utility	1
City of Salem - PW Pump Station	Sanitation utility	1
City of Salem Water Reservoir Control - Bldg. Shell	Water utility	1
City of Salem Wet Weather Treatment - Bldg.	Sanitation utility	1
City of Salem Pump Station	Water utility	1

Facility Name	Property Use	Facility Priority
City of Salem Pump Station Generator	Outbuilding or shed	1
City of Salem Reservoir Ops. Bldg..	Ind.- utility- defense- agriculture- mining- other	1
City of Salem River Rd Pump Station	Sanitation utility	1
City Water Pump Station	Water utility	1
D & O Garbage Wash Rack - Bldg. Shell	Sanitation utility	1
D.O.T. Materials Testing Lab	Ind.- utility- defense- agriculture- mining- other	1
Marion County Archives	Ind.- utility- defense- agriculture- mining- other	1
Marion County Hazardous Waste Facility	Sanitation utility	1
National Guard Armory Auditorium	Ind.- utility- defense- agriculture- mining- other	1
Orchard Heights Pump Station	Water utility	1
Oregon Dept. of Agriculture	Ind.- utility- defense- agriculture- mining- other	1
Public Works Water Meter Repair	Warehouse	1
Pump Station - City of Salem - Bldg. Shell	Undetermined	1
Salem ASR	Water utility	1
Septic Building	Sanitation utility	1
Woodmansee Pumphouse	Water utility	1

Source: *2023 Salem NHMP* Steering Committee

Physical Infrastructure

Physical infrastructure includes transportation networks, dams, and utilities. These infrastructures support the Salem community and economic activity. Due to the fundamental role that physical infrastructure plays both in pre- and post-disaster, they deserve special attention in the context of creating resilient communities (DLCD, 2020)).

Transportation

Roads & Bridges

Roads and bridges in the City of Salem are highly vulnerable to hazards specifically earthquakes. Because bridges vary in size, materials, siting, and design, any given hazard will affect them differently. When considering the expanse and integrity of transportation infrastructure within Salem and how it will impact the resilience of the city, it is imperative that infrastructure across Marion County is also considered. If a principal arterial is obstructed beyond the city limits it will have significant impacts on access in and out of Salem.

Interstate-5 (I-5) is the principal arterial that connects Salem to northern and southern Oregon, and traverses through the interior of the city. There are also two non-interstate principal arterials: Oregon Highway 22 and 99E. Highway 22 runs east and west, connecting the Oregon Coast to Central Oregon through Salem. Highway 99E runs north and south and provides connections to Interstate-205 (I-205) at Oregon City, as well as Corvallis and Eugene to the south. Both non-interstate principal arterials serve as the main access for rural areas outside of Salem, including, Dallas, Independence, and Monmouth. See Figure C-14 for more information on Salem streets.

Bridge condition surrounding the city is also a factor that affects risk from natural hazards. Bridges damaged by hazards such as earthquakes can disrupt traffic and exacerbate economic losses because of the inability of industries to transport services and products to clients. The Marion County has assigned bridges with an operating rate, which determines whether overweight trucks can receive a permit to cross the bridge and if any requirements will be placed on their usage of the bridge. Six bridges just beyond the Salem City limits are presently restricted to certain maximum vehicle weights or dimensions. Table C-20 lists the weight and height restrictions of these bridges and shows the functional class of the roadway crossing that bridge.

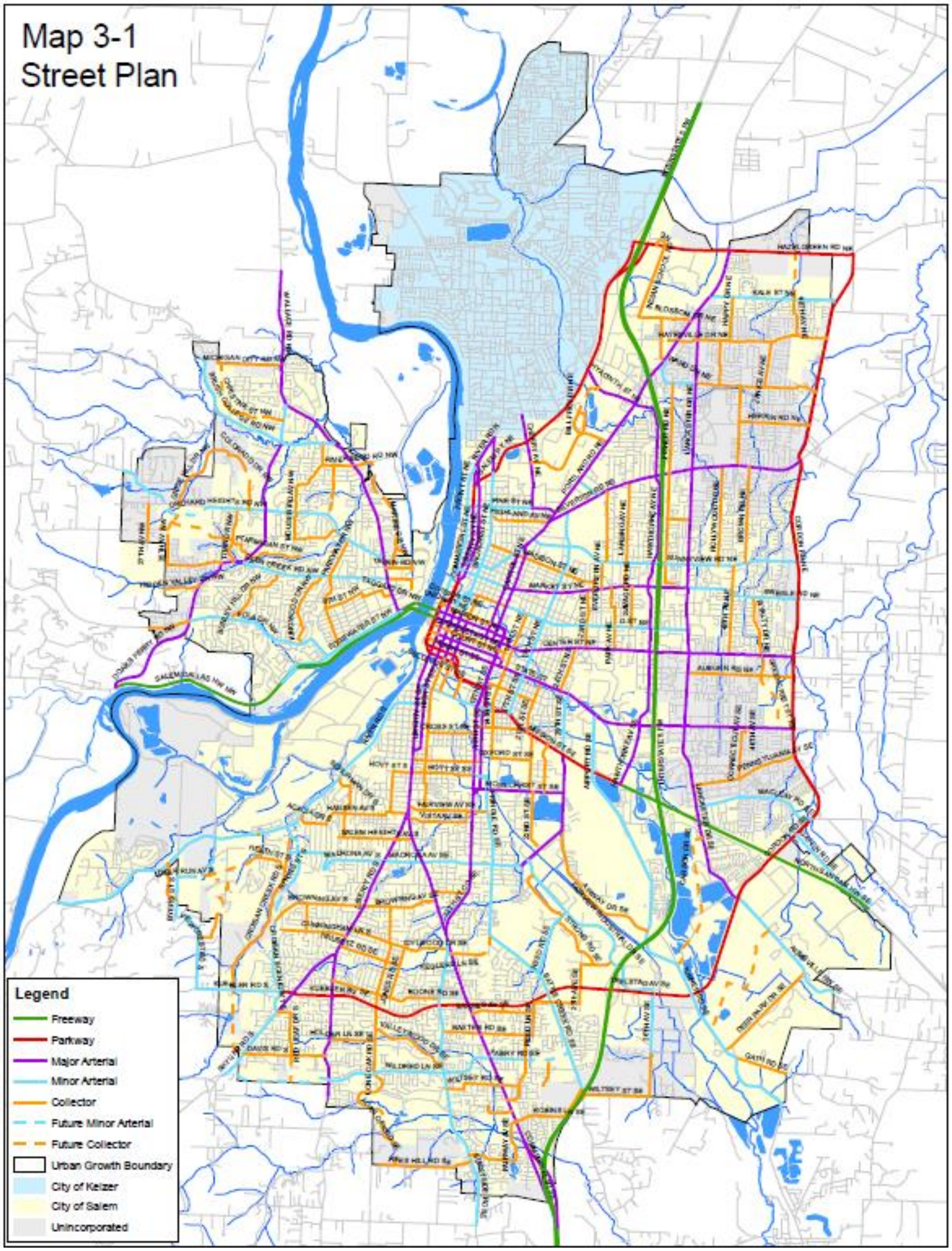
Table C-20 Marion County Bridges: Height and Weight Restrictions

Bridge	Over	Restrictions	Functional Class
Gallon House Road	Abiqua Creek	20 Tons, height: 14’2”	Local
Mt. Angel-Gervais Road	Pudding River	20-39 Tons*	Minor Collector
Jefferson-Marion Road	SP Railroad	40 Tons	Arterial
Labish Center Road	Little Pudding River	40 Tons	Minor Collector
Rambler Drive	Little Pudding River	40 Tons	Local
River Road South	Willamette River	40 Tons	Arterial

Source: Marion County, 2005
*Weight dependent on configuration

Limiting maximum vehicular weight on bridges can reduce bridge maintenance, extend bridge lifespan, and preserve transportation system continuity. Bridges provide functional links for Salem transportation corridors, and if they are not maintained the bridge may become unusable in the event of a natural disaster, effectively isolating the city if no other alternative transportation network exists.

Figure C-14 Salem Street Plan



Source: City of Salem, 2020

Note: Map 3-1 of the Salem Transportation System Plan

Alternate Modes of Transport

Other important modes of transportation include railway (passenger and freight), airports, public transportation, and pedestrian and bicycle routes. Union Pacific and Oregon Short Lines operate freight lines that traverse through Salem, connecting the transport of products to Washington and California (Oregon Department of Transportation, 2022). The Oregon Department of Transportation and Amtrak Cascades also identify various Amtrak passenger routes through the city including Routes 11, 14, 500, 503, 505, 508, and Coast Starlight. These routes transport people within the State and to Washington and California. Facilities that support air travel include McNary Field, the only commercial service public use airport, three private use airports, and one heliport at the Salem Hospital, according to Oregon Airport Directory (Oregon Department of Aviation, 2020). Salem's public transit services include Cherriots (officially the Salem Area Mass Transit District), serving the Salem-Keizer urban and regional areas, and include Cherriots Local, Cherriots Regional (formerly Chemeketa Area Regional Transportation System or CARTS), Cherriots LIFT (paratransit), and Cherriots Shop and Ride. Cherriots buses also include bike racks with a capacity for two bicycles. Salem and the surrounding Urban Growth Area has an extensive pedestrian and bicycle network. According to the Salem Transportation Plan, the city strives to evaluate, improve upon, and add new trails and safety features on existing roads and in parks to help cyclists and pedestrians move more safely through the community.

Dams

Dams play a crucial role in power generation and water control mechanisms for the region. Dam failures can occur rapidly and with little warning, according to FEMA's Dam Safety program. 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 located across Marion County and Salem. The "hazard level" estimates the amount of damage that could occur in the event of dam failure.

Marion County has over 56 dams, and two are ranked at a high hazard level: Detroit Dam and Big Cliff Dam. Detroit Dam and Big Cliff Dam are hydroelectric dams that control the flow of water on the Santiam River, providing a major boating and recreational area. However, both dams are considered a major hazard for the large population downstream that would be at risk in the event of a dam failure, including populations in Salem. Besides the Detroit and Big Cliff dams, there are two High Hazard Potential Dams – Croft and Franzen – regulated by Oregon that, if they were to fail, could impact to Salem. These two dams, either within or in proximity of city limits, are assigned a hazard rating based on downstream hazard to people and property, not on the condition of the dam. Additional details regarding these two dams can be found in Section 2, Risk Assessment under the Flood hazard.

Utility Lifelines

Utility lifelines are the resources that the public relies on daily, (i.e., electricity and fuel). 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.

More than half of Oregon's electricity comes from hydropower, and about one percent comes from renewable sources, primarily biomass and wind (Loy et al., 2001). The network of electricity transmission through Salem and the greater Marion County area is operated and distributed by the Bonneville Power Administration and Pacific Power (Loy et al., 2001).

Oregon does not have any crude oil resources or refineries, and so must import all its petroleum products. According to the Oregon Department of Energy's Assurance Plan (2012), most petroleum is extracted and refined regionally – 90% of Oregon's petroleum products are refined in the Puget Sound area of Washington and 80% of the crude oil used to make these products comes from Alaska's North Slope oil fields. The remainder of Oregon's petroleum comes primarily from refineries in Utah and British Columbia. Most of Oregon's oil enters on tanker ships at the Port of Portland and is then distributed via tanker truck or via the Kinder-Morgan pipeline, which runs from Portland south to Eugene (Lewis et al., 2012). Although the Kinder-Morgan pipeline passes through Salem, it does not have an outlet there; Salem receives its petroleum via tanker truck. Oregon's petroleum supply system has many vulnerabilities that pose a risk to Salem. First, there is the possibility for disruption of the transmission system: the pipelines are 30 years old, and tanker trucks rely on the road network (Lewis et al., 2012).

Synthesis

Given that Salem is the State Capital and the second largest city in the state, it is that much more critical to maintain the quality of built capacity throughout the area, as it is likely that surrounding jurisdictions will seek assistance from Salem. The planning considerations most significant for the city are contingency planning for emergency services, medical resources, and lifeline systems. As mentioned above, functionality of the critical facilities should be a significant priority in providing for the Salem community. To maintain functionality, memorandums of understanding can be established with surrounding cities and counties for medical transport, treatment, utility and transportation lifeline 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 Capacity

Community connectivity capacity 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 capital is present in all communities; however, it may be dramatically different from one town to the next as these capitals reflect the specific needs and composition of the community residents.

Social Systems

Social systems include community organizations and programs that provide community-based services, such as employment, health, homeless, senior and disabled services, professional associations, and veterans' affairs for the public. 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.). The city can use existing social systems as resources for implementing such communication-related activities because these service providers already work directly with the public on many issues, one of which could be natural hazard preparedness and mitigation.

The following is a brief explanation of how the communication process works and how the community's existing social service providers could be used to provide natural hazard related messages to their clients.

There are five essential elements for communicating effectively to a target audience:

- The source of the message must be credible,
- The message must be appropriately designed,
- The channel for communicating the message must be carefully selected,
- The audience must be clearly defined, and
- The recommended action must be clearly stated, and a feedback channel established for questions, comments and suggestions.

The social organizations identified in Salem can be involved in hazard mitigation; a few methods are defined below.

- <u>Education and outreach</u> – organization could partner with the community to educate the public or provide outreach assistance on natural hazard preparedness and mitigation.
- <u>Information dissemination</u> – organization could partner with the community to provide hazard related information to target audiences.
- <u>Plan/project implementation</u> – 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.

Historic Resources

Historic resources such as historic structures and landmarks can help to define a community and may also be sources for tourism revenue. Because of their role in defining and supporting the community, protecting these resources from the impact of disasters is important.

The City of Salem has a rich history. According to the city, the spot along the Willamette River that is Salem has drawn people since before recorded history, when the resident Kalapuya tribe called the area Chim-i-ki-ti, meaning “meeting or resting place.” Salem was founded in 1842 and became the capital of the Oregon Territory in 1851. It has served as the capital of the State of Oregon since its establishment in 1859.

The Oregon Department of Historic Preservation reports numerous historically significant structures within Salem and National Register of Historic Places reports 79 historically significant structures in Marion and Polk Counties. A complete list of structures and landmarks can be found on the Oregon State Historic Preservation Office website: https://www.oregon.gov/oprd/OH/Pages/default.aspx

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 they 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.

Salem Public Library is part of the City of Salem. According to the City of Salem, the Main Library is at 585 Liberty St SE, next to the Civic Center in downtown Salem. The West Salem Branch Library is located at 395 Glen Creek Road NW. The Salem’s Women’s Club founded the library in 1904. The library, in its current location, underwent seismic and safety renovation in 2021. The West Salem Branch Library began in 1957 in the old West Salem City Hall and has been at its current location since 1995.

There are at least four museums in Salem, according to the City of Salem, including the Deepwood Gardens and Museum, Hallie Ford Museum of Art, Willamette Art Center, Bush Barn Art Center and Annex, Oregon State Hospital Museum of Mental Health, Gilbert House Children’s Museum, and the Lord and Schryver Conservancy. Salem also has public art throughout the city and can be explored through Explore Public Art in Salem.

Cultural Resources

Similar to historic resources, cultural resources and events, can help to define a community and may also be sources for tourism revenue. These resources and events can strengthen community connectivity and can include festivals and organizations that engage diverse cultural interests.

The Marion Cultural Development Corporation maintains the historic and cultural resources across Salem. The non-profit preserves, enhances and supports the arts, history, architecture, libraries, museums, festivals, and other cultural assets for the public. Examples include the Elsinore Theatre, which is a cultural landmark and World Beat Gallery and

Festival (Travel Salem). The Oregon State Fair also takes place every August–September at a 185-acre site in north Salem. as it has almost every year since 1862 (Wikipedia).

In addition, the City of Salem has over 250 known archaeological sites within its boundaries. Archaeological resources below the surface of buildings and urban environment are often the only source of knowledge about a city's prehistory and the largely undocumented history and lives of our historically marginalized populations, immigrants and the poor. The city has an archaeological compliance program to establish processes to identify these resources, assess their significance and mitigate potential damage development may do to these resources.

Community Stability

Residential Geographic Stability

Community stability is a measure of rootedness in place. It is hypothesized that resilience to a disaster stems in part from familiarity with place, not only for navigating the community during a crisis, but also accessing services and other supports for economic or social challenges (Cutter et al., 2010).

Table C- estimates residential stability across the region. It is calculated by the number of people who have lived in the same house and those who have moved within the same city a year ago, compared to the percentage of people who have migrated into the region. Salem overall has geographic stability rating of about 91.2% (i.e., 91.2% of the population lived in the same house or moved within the county in the last year). For those that moved into the city, 5.2% of residents lived in a different Oregon city one year before, 3.0% lived in a different state and <1% lived in a different country (Social Explorer, 2018).

Table C-21 Regional Residential Stability

Statistics	Marion County		Polk County		Salem	
Total	331,474		80,570		164,584	
Same House 1 Year Ago	277, 997	83.96%	66,724	82.8%	131,563	79.9%
Moved within Same County	31,853	9.6%	4,830	6.0%	18,576	11.3%
Moved from Different County within Same State	12,599	3.8%	6,691	8.3%	8,621	5.2%
Moved from Different State	7,455	2.3%	1,860	2.3%	4,855	3.0%
Moved from Abroad	1,570	0.5%	465	0.6%	969	0.6%

Source: Social Explorer, 2018

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. As noted in Table C-22 below, about 53.3% of the occupied housing units in Salem are owner-occupied; about 46.7% are renter occupied. Salem’s vacancy rate is about 7%.

Table C-22 Housing Tenure and Vacancy

	Housing Units	Owner-occupied		Renter-occupied		Vacant	
Total	146,553	88,910		57,643		10,399	
Marion County	116,861	69,495	59.5%	47,366	40.5%	8,329	6.7%
Polk County	29,692	19,415	65.4%	10,277	34.6%	2,070	6.5%
Salem	59,693	31,826	53.3%	27,867	46.7%	4,357	6.8%

Source: Social Explorer, 2018

According to Cutter (2003), 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. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable post-disaster.

Synthesis

Salem has social and cultural resources that work in favor to increase community connectivity and resilience. Sustaining and preserving social and cultural resources such as, social services and historic places may be essential to preserving community cohesion and a sense of place. All communities have social systems that could help raise awareness of available resources and services for the public. It may be of specific interest to these communities to evaluate social and cultural resources periodically to get a sense of what exists, what is needed, and who can provide it. It is important to consider that these social services may not be equally accessible to residents of rural areas beyond Salem jurisdictional boundaries, and Salem may need to expand these provisions beyond traditional service areas.

Political Capacity

Political capacity includes 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 (Mileti, 1999). Resilient political capital seeks to involve various stakeholders in hazard planning and works towards integrating the Natural Hazard Mitigation Plan with other community plans, so that all planning approaches are consistent.

Government Structure

Salem operates under the council-manager form of city government. The Mayor and the eight City Councilors are elected by the citizens, and they develop the policies that direct city operation. The Mayor and Council hire the City Manager to implement policy direction and manage city operations. The City Charter provides the authority under which the city operates and outlines roles of the Mayor, Council, and City Manager (City of Salem).

Beyond Emergency Management, most departments within the city governance structure have some degree of responsibility in building overall community resilience. Each plays a role in ensuring that city functions and normal operations resume after an incident, and the needs of the population are met.

Some departments of Salem government that have a role in hazard mitigation are the following (City of Salem):

- **City Manager's Office** directs the day-to-day administration of the City through Department Directors and directs the work of staff in the City Manager's Office (CMO). This office helps to organize, coordinate, and manage City government operations based on City Council direction, state and federal law, and City ordinance.

- **Community Development Department** works to ensure the strength of our community at the neighborhood level and citywide through support for planning and civic involvement, permitting, inspecting and, where needed, protecting historic community resources and providing library services.

- **Community Services Department** provides recreation and life enhancement opportunities to Salem residents by managing the City's Parks and Recreation programs, Public Library, and Center 50+

- **Public Works Department** plans, constructs, and maintains the infrastructure necessary for the basic urban needs of the Salem metropolitan area. This includes a safe and reliable road system including bicycle and pedestrian lanes or pathways healthy and plentiful water supply, a well-functioning storm drainage system, and proper treatment of wastewater. Transportation maintenance and operations funding predominantly relies on gas tax revenue, supported by a dedicated transportation fund in Salem. Regarding infrastructure, construction is financed through a combination of resources like Transportation System Development Charges (SDCs), grants, gas tax proceeds, and bonds, with a primary goal of minimizing General Fund (GF) usage for capital projects. In contrast, the utility department operates independently through its fee structure, while the Building and Safety department is self-sustained by fee collections.

- **Enterprise Services Department** consolidates several services including human resources and information technology, in support of business continuity and citywide strategic initiatives.
- **Salem Housing Authority** is to assist low- and moderate-income families to achieve self-sufficiency through stable housing, economic opportunity, community investment, and coordination with social service providers.
- **Salem Police Department** brings police and citizens together to better fight crime in the community. Their mission is to reduce the fear of crime, protect individual rights, and enhance the quality of life.
- **Salem Fire Department** is an all-hazard response agency that has been trained to mitigate emergencies involving fire, hazardous materials, and technical rescue (including rope rescue, water, confined space building collapse, and trench rescue). Emergency medical services and medical response are also a fundamental responsibility of the Salem Fire Department, and providers respond to a wide variety of medical calls, ranging from minor medical assistance to life-threatening events.
- **Urban Development Department** administers programs and services that promote awareness of economic and community development programs, services, and economic incentives offered by the City of Salem and Urban Renewal Agency (URA); leverages (URA)/City funds against available area sources for economic development activities; and works with economic development partners and the development community to actively promote investment in the Salem community.
- **Urban Renewal Agency** is a financial tool that funds projects and activities in an urban renewal area which have been identified in an urban renewal plan. The purpose of urban renewal is to make public investments in designated geographic areas to remove blight, to improve property values, and to leverage private investment. Public investments spur redevelopment in areas where it might not otherwise occur.

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. Plans and policies already in existence have support from residents, businesses, and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, and can adapt easily to changing conditions and needs (Burby, 1998).

The City of Salem NHMP includes a range of recommended action items that, when implemented, will reduce the city's vulnerability to natural hazards. Many of these recommendations are consistent with the goals and objectives of the city'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 natural hazards mitigation plan's action items through existing plans and policies increases their likelihood of being supported and getting updated and maximizes the city's resources.

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

- City Budget
- Community Wildfire Protection Plans
- Comprehensive Land Use Plans
- Economic Development Action Plans
- Emergency Operations Plans
- Zoning Ordinances and Building Codes

The specific plans that presently exist related to this NHMP and the FEMA requirements are listed in Table C-23, below. These are the same plans listed in Table in Section 4, Plan Implementation and Maintenance.

Table C-23 City of Salem NHMP Supported Plans and Policies

Document	Year
Natural Hazards Mitigation Plan	2023, 2017 previous
Salem Emergency Management Plan	2023, 2018/2020 previous
Salem Fire Department Standards of Cover, 2018-2023	2018
Salem Area Comprehensive Plan	2022
Salem Revised Code	2017 recodified
Title V, Community Development Standards	
Title VI, Wastewater, Water and Stormwater	
Title VII, Permits, Streets and Public Ways	
Title X, Unified Development Code	
Salem Climate Action Plan	2021
2021 Inventory of Community Greenhouse Gas Emissions	2023, 2019 previous
Salem's Community Energy Strategy	2010
Salem Floodplain Management Plan	2018
Salem Transportation System Plan	2020
Salem Comprehensive Park System Plan	2013
Salem Historic Preservation Plan 2020-2030	2020
Salem Water Management and Conservation Plan	2019
Salem Water System Master Plan	1994
Stormwater Master Plan	2020

Document	Year
Stormwater Drainage Basin Plans	2019
Battle Creek Basin Plan	
Mill Creek Basin Plan	
Pringle Creek Basin Plan	
Sheltering Crisis Response	2022
Snow and Ice Control Plan	2019
Community Forestry Strategic Plan	2013
Salem Strategic Plan 2021-2026	2021, 2017 previous
Salem Municipal Airport Master Plan	2012
Franzen Dam Emergency Operations Plan	2019
Croft Reservoir Dam Emergency Operation Plan	2018
North Santiam Watershed Council North Santiam Watershed Drought Contingency Plan	2018, update in process
Marion County Community Wildfire Protection Plan	2017

Source: *2023 Salem NHMP* Steering Committee

Synthesis

As addressed above, many governmental entities are responsible for work relevant to hazards planning; however, from this perspective it is challenging to decipher whether these structures work collaboratively in practice towards improving hazard mitigation. On a similar note, in short of reviewing each of the relevant policy documents it is questionable whether the documents effectively integrate hazard initiatives into implementation policy. Further analysis is needed to evaluate the effectiveness of political capital in terms of community resilience.

Appendix D:
Economic Analysis of
Natural Hazard Mitigation Projects

This appendix was originally developed by the Oregon Partnership for Disaster Resilience (OPDR) at the University of Oregon's Community Service Center (now the Institute for Policy Research and Engagement or IPRE) and included many of the NHMPs that OPDR/IPRE did with local jurisdictions. It has been reviewed and accepted by the Federal Emergency Management Agency (FEMA) as a means of documenting how the prioritization of actions shall 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.

- Benefit/Cost Analysis
- Cost-Effective Analysis
- STAPLE/E Approach

The appendix describes the importance of implementing mitigation actions, 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 Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon Department of Emergency Management, 2000), and 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 actions reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs. Evaluating possible natural hazard mitigation actions provide decision-makers with an understanding of the potential benefits and costs, 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 such as these three.

- Natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, law enforcement, utilities, and schools.
- 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.

- Many of the impacts of such events produce “ripple-effects” throughout the community, 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 actions and obtaining an instructive benefit/cost comparison.

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.

Benefit/Cost Analysis

Benefit/cost analysis is a key mechanism used by OEMFEMA, 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 action. A benefit/cost analysis for a mitigation action 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 (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 Actions

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all 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 Actions

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:

- Request cost sharing from public agencies;
- Dispose of the building or land either by sale or demolition;
- Change the designated use of the building or land and change the hazard mitigation compliance requirement; or
- 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 action could be very time consuming and impractical. There are some alternate approaches for conducting a quick evaluation of the proposed mitigation actions which could be used to identify those mitigation actions that merit more detailed assessment. One of those methods is the STAPLE/E approach.

Using STAPLE/E criteria, mitigation actions can be evaluated quickly by steering committees in a synthetic fashion. This set of criteria requires the committee to assess the mitigation actions based on the Social, Technical, Administrative, Political, Legal, Economic and Environmental (STAPLE/E) constraints and opportunities of implementing the particular mitigation item in your 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 S*tate 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 considering 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 city 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 considered?
- 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.

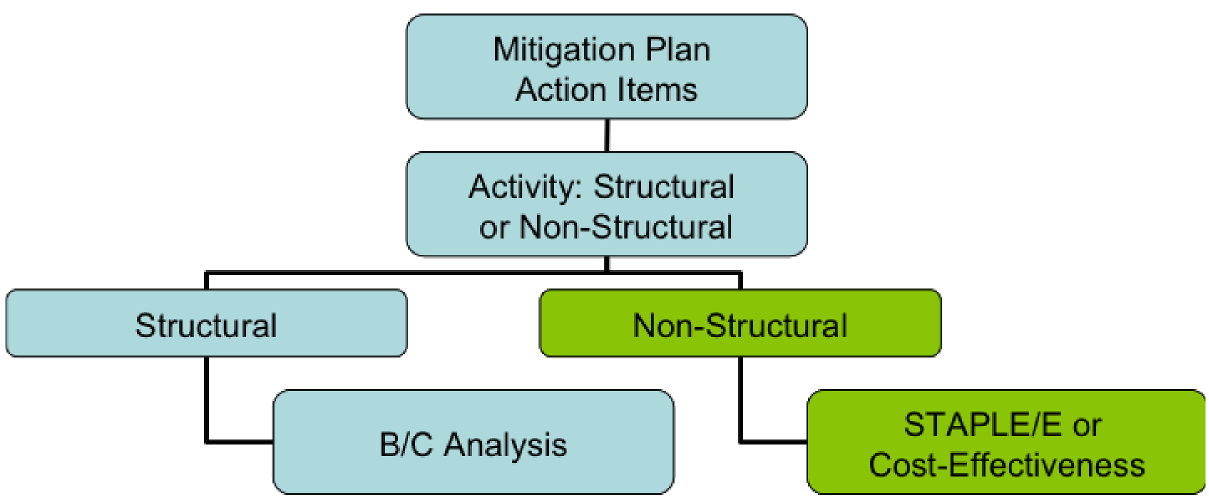
- How will the action impact the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

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 D-1 Economic Analysis Flowchart



Source: Institute for Policy Research and Engagement in the School of Planning, Public Policy and Management. (2005) Oregon Partnership for Disaster Resilience. University of Oregon. Retrieved from https://opdr.uoregon.edu/.

Implementing the Approaches

Below is a framework that could be used in further analyzing the feasibility of implementing prioritized actions after determining – using one of the economic analysis approaches described above – whether to implement the mitigation action.

1. Identify the Actions

Actions 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 actions. 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 a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Actions

Once costs and benefits have been quantified, economic analysis tools can rank the possible mitigation actions. Two methods for determining the best actions 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.

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 action. 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 actions.

Additional Considerations

Conducting an economic analysis for potential mitigation actions 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 actions.

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. 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

These items support the development and funding of hazard mitigation actions:

Federal Emergency Management Agency. (Mar. 2007). *Appendix D: Determining Cost Effectiveness*; From FEMA Publication 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*. Available at https://www.fema.gov/sites/default/files/2020-08/fema_551.pdf

Federal Emergency Management Agency. (Jan. 2017). Benefit Cost Toolkit Version 6.0 Available at https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis

Federal Emergency Management Agency. (Feb. 2019). *Fact Sheet Public Assistance Management Costs Interim Policy*. Available at https://www.fema.gov/sites/default/files/2020-07/fema_DRRA-1215-management-costs-public-assistance-fact-sheet.pdf

Federal Emergency Management Agency. (Mar. 2023). *Hazard Mitigation Assistance Program and Policy Guide*. Available at https://www.fema.gov/sites/default/files/documents/fema_hma-program-policy-guide_032023.pdf

Goettel, K. (Nov. 2016). *Benefit-Cost Analysis of the Proposed Seismic Retrofit Ordinanc*e. Goettel and Associates for the City of Portland, Oregon.

Lehman, D. and S. Loper. (1996). *Report on the Costs and Benefits of Natural Hazards Mitigation*. Prepared by Woodward-Clyde Federal Services for FEMA. Available at https://www.fema.gov/media-library-data/20130726-1511-20490-6222/haz_cost.pdf

Rose, A., K. Porter, N. Dash, J. Bouabid, et al. (2007). Benefit-Cost Analysis of FEMA Hazard Mitigation Grants. Natural Hazards Review. 8. 97-111. 10.1061/(ASCE)1527-6988(2007)8:4(97). https://www.researchgate.net/publication/4729207_Benefit-Cost_Analysis_of_FEMA_Hazard_Mitigation_Grants. Accessed January 23, 2020.

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. https://www.fema.gov/media-library/assets/documents/96200.

APPENDIX E:
GRANT PROGRAMS AND RESOURCES

Introduction

There are numerous local, state, and federal funding sources available to support natural hazard mitigation projects and planning. The following section includes a list of 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 and program descriptions.

Grant Programs and Resources

Federal: Pre-/Post-Disaster

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. BRIC grants are available on an annual basis. Applicants need to submit a letter of interest to the State Hazard Mitigation Officer, annually in September. The grant is administered by FEMA.

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. This new, competitive grant program provides the opportunity to collaboratively implement transformational regional projects that build immediate and long-term resilience in coastal areas.

Community Development Block Grant (CDBG) Program

https://www.hud.gov/program_offices/comm_planning/cdbg-dr

The CDBG Program, administered by HUD, 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.

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.

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 Resources, HUD

https://www.hud.gov/disaster_resources

The U.S. Department of Housing and Urban Development (HUD) provides a variety of disaster resources listed below. We also partner with Federal and state agencies to help implement disaster recovery assistance. Under the National Response Framework, FEMA and the Small Business Administration (SBA) offer initial recovery assistance.

Emergency Management Performance Grants (EMPG), FEMA

https://www.fema.gov/grants/preparedness/emergency-management-performance

Emergency Management Performance Grant program helps state and local governments to sustain and enhance their all-hazards emergency management programs.

Flood Mitigation Assistance (FMA) Program, FEMA

http://www.fema.gov/flood-mitigation-assistance-program

The overall goal of the 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.

Food and Nutrition Service (FNS) Disaster Resources, USDA

https://www.fns.usda.gov/disaster/disaster-assistance

The 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).

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. Flood mitigation assistance is usually offered annually; applications are submitted online. Applicants need a user profile approved by the State Hazard Mitigation Officer (SHMO), which should be garnered well before the application period opens.

For Oregon Department of Emergency Management (OEM) grant guidance on Federal Hazard Mitigation Assistance, visit: https://www.oregon.gov/OEM/emresources/Grants/Pages/HMA.aspx

Contact: Anna Feigum, State Hazard Mitigation Officer (SHMO), anna.r.feigum@oem.oregon.gov

Hazard Mitigation Grant Program (HMGP), FEMA

https://www.fema.gov/grants/mitigation/hazard-mitigation

The 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 HMGP involves a paper application which is first offered to the counties with presidentially declared disasters within the past year, then becomes available statewide if funding is still available. The grant is administered by FEMA.

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.

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 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.

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), 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.

Public Assistance (PA) Grant Program, FEMA

http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit

The objective of the FEMA Public Assistance 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.

Regional Catastrophic Preparedness Grant Program (RCPGP), FEMA

www.fema.gov/grants

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.

Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program, FEMA

https://www.fema.gov/emergency-managers/risk-management/dam-safety/rehabilitation-high-hazard-potential-dams

The Rehabilitation of HHPD awards provide technical, planning, design and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams. A state or territory with an enacted dam safety program, the State Administrative Agency, or an equivalent state agency, is eligible for the grant.

Rural Development Assistance – Utilities, USDA

https://www.rd.usda.gov/about-rd/agencies/rural-utilities-service

USDA's Rural Utilities Service (RUS) provides much-needed infrastructure or infrastructure improvements to rural communities. These include water and waste treatment, electric power and telecommunications services. All these services help to expand economic opportunities and improve the quality of life for rural residents.

Rural Development Assistance – Housing, USDA

https://www.rd.usda.gov/about-rd/agencies/rural-housing-service

USDA's Rural Housing Service (RHS) offers a variety of programs to build or improve housing and essential community facilities in rural areas. We offer loans, grants and loan guarantees for single- and multifamily housing, childcare centers, fire and police stations, hospitals, libraries, nursing homes, schools, first responder vehicles and equipment, housing for farm laborers and much more. The RHS also provide technical assistance loans and grants in partnership with non-profit organizations, Indian tribes, state and federal government agencies, and local communities.

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.

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.

Federal: Fire Resources

Assistance to Firefighters Grant (AFG) Program Resources, FEMA

https://www.fema.gov/grants/preparedness/firefighters/assistance-grants

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.

Community Wildfire Defense Grant (CWDG) Program, USDA-FS

https://www.fs.usda.gov/managing-land/fire/grants

The CWDG is intended to help at-risk local communities and Tribes; plan for and reduce the risk of wildfire. The 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 also helps communities in the wildland urban interface (WUI) implement the three goals of the National Cohesive Wildland Fire Management Strategy.

Fire Management Assistance Grant (FMAG) Program, FEMA

https://www.fema.gov/assistance/public/fire-management-assistance

Fire Management Assistance Grant (FMAG) Program is available to states, local and tribal governments, for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands, which threaten such destruction as would constitute a major disaster.

Fire Prevention and Safety (FP&S), FEMA

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.

National Fire Plan (NFP), USDA/USDOI

http://www.forestsandrangelands.gov/

The 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.

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.

Wildfire Smoke Preparedness in Community Buildings Grant Program, EPA

https://www.epa.gov/indoor-air-quality-iaq/wildfire-smoke-preparedness-community-buildings-grant-program?utm_content=&utm_medium=email&utm_name=&utm_source=govdelivery&utm_term=#Eligible

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: Hazard Mapping and Technical Support

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.

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.

Cooperating Technical Partners (CTP), FEMA

https://www.fema.gov/flood-maps/guidance-partners/cooperating-technical-partners

The CTP mission is to strengthen the effectiveness of the NFIP and support FEMA's mitigation objectives. The CTP Program leverages partnerships to deliver high-quality hazard identification and risk assessment products, provide outreach support and empower communities to take action to reduce risk based on informed, multi hazard-based data and resources.

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 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:

Emergency Watershed Protection (EWP) Program, USDA-NRCS

https://www.nrcs.usda.gov/programs-initiatives/ewp-emergency-watershed-protection

The EWP Program 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.

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.

National Coastal Zone Management (CZM) Program, NOAA

https://coast.noaa.gov/czm/

The National CZM Program comprehensively addresses the nation's coastal issues through a voluntary partnership between the federal government and coastal and Great Lakes states and territories. Authorized by the Coastal Zone Management Act of 1972, the program provides the basis for protecting, restoring, and responsibly developing our nation's diverse coastal communities and resources. The CZM Program 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 Flood Insurance Program (NFIP), FEMA

https://www.fema.gov/flood-insurance

The NFIP provides insurance to help reduce the socio-economic impact of floods. The NFIP insurance is made available to residents of communities that adopt and enforce minimum floodplain management requirements.

NFIP Flood Maps, FEMA

https://www.fema.gov/flood-maps

Floods occur naturally and can happen anywhere. They may not even be near a body of water, although river and coastal flooding are two of the most common types. Heavy rains, poor drainage, and even nearby construction projects can put the community at risk for flood damage. Flood maps (referred to as Flood Insurance Rate Maps or "FIRM") are one tool that communities use to know which areas have the highest risk of flooding. FEMA maintains and updates data through flood maps and risk assessments.

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.

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.

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 fiscal year 2022, 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.

State

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 Risk Reduction Grants, OSFM

https://www.oregon.gov/osp/programs/sfm/Pages/OSFM-Grants.aspx

The Oregon State Fire Marshall (OSFM) grant programs provides the following funding sources.

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.

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.

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.

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.

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.

Grants and Supports for Emergency Shelter, ODHS

https://www.oregon.gov/dhs/EmergencyManagement/Pages/emergency-shelter.aspx

Oregon Department of Human Services (ODHS) proves assistance for local governments, Tribal Nations and public education providers to address shelter needs for:

- Cleaner air shelters during wildfire smoke and other poor air quality events
- Cooling and warming shelters

Oregon Senate Bill 80 (SB 762 fixes) proposes to extend eligibility to non-profits and faith-based organizations.

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 Watershed Enhancement Board (OWEB)

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 effort 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.

Seismic Rehabilitation Grant Program (SRGP), 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) offered the following two funding opportunities: the Small Forestland Grant and the Firewise Community Grant. Both opportunities require grant dollars are spent reducing the risk of high severity wildfire through the reduction of hazardous fuel on small forestland owner properties. Both opportunities were scored prioritizing high-risk watersheds, but lower risk watersheds were not excluded from applying. All invoices from both program components must be submitted by successful recipients no later than June 15, 2023.

Smoke Management-Community Response Plan Grant, DEQ

https://www.oregon.gov/deq/aq/Pages/Smoke-Resources.aspx

Communities throughout Oregon are at various stages of planning and preparing for the potential impacts from prescribed fire and wildfire smoke. To create a successful community response plan for smoke, communities need to partner with local stakeholders and apply the best practices and resources to meet the needs of their residents. In 2022, Oregon Department of Environmental Quality (DEQ) awarded grants to 20 local and tribal governments to develop comprehensive community response plans for smoke management and to three local entities and businesses to pilot projects promoting alternatives to open burning. Once the grant period is completed, DEQ will share community response plans and best practices from the grant awardees.

State Interagency Hazard Mitigation Team (IHMT)

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 made up 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), OEM

https://www.oregon.gov/oem/emresources/Grants/Pages/Spire.aspx

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. The contact for the SPIRE program is Carole Sebens, Grants Coordinator, Carole.L.Sebens@oem.oregon.gov/

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 is deployed.

Deferred and Lifetime Maintenance Funding

Other considerations about how to use lines of funding 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 (GO Bond)

A general obligation bond, or 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, the rules for issuing GO Bonds are 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

Pursuant to ORS 373.240, the "general road fund" of any city shall consist of the road money set apart for the city as a road district or otherwise, under the laws of the state, out of the road tax levied by the county, which the county treasurer shall pay to the city, and any other money placed in the road fund of the city by the orders of the city governing body.

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

City of Salem

Local funding depends on the jurisdiction's funding mechanisms. The following includes additional and common funding mechanisms that may contribute to funding hazard mitigation projects in Salem.

- The General Fund is the primary funding resource for the City of Salem, including mitigation actions. This Fund comprises various revenue sources, such as property taxes, sales taxes, and grants.
- Transportation maintenance and operations funding predominantly relies on gas tax revenue, supported by a dedicated transportation fund in Salem.
- Infrastructure construction is financed through a combination of resources like Transportation System Development Charges (SDCs), grants, gas tax proceeds, and bonds, with a primary goal of minimizing General Fund usage for capital projects.
- The utility department operates independently through its fee structure. Salem has stormwater utility fees to fund stormwater management and flood control projects.

These fees are assessed on property owners and can be earmarked for mitigation actions.

- The Building and Safety department is self-sustained by fee collections.
- The Planning Department, although generating a substantial portion of its revenue, receives supplementary support from the General Fund to ensure its sustainability.
- Salem has impact fees for development; these fees can be allocated for mitigation projects, primarily if they address issues related to new developments and their potential impact on disaster resilience.

Foundational

Meyer Memorial Trust (MMT)

https://mmt.org/

Since 1982, the MMT has awarded grants and program-related investments totaling more than $814 million to more than 3,380 organizations around the Pacific Northwest. Today, MMT 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.

Oregon Community Foundation (OCF)

https://oregoncf.org

The 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.

APPENDIX F: LIFELINE SECTOR ASSESSMENT

The following lifeline sector analysis summary evaluates key resources and facilities within specific sectors through sector stakeholder feedback. The *2023 Salem NHMP* Steering Committee evaluated and decided to retain the information below that was originally presented in the *2017 Salem NHMP*.

Note: This chapter originally appeared in the Marion County NHMP (2017) and is included herein in its entirety, except for some formatting and grammatical edits.

This section describes the findings from the 2016 Marion County Lifeline Sector Assessment. In 2015, a University of Oregon Community Planning Workshop student team conducted an assessment of lifeline sectors identified by Marion County – transportation, energy, communication, and water. The assessment focused on review of each sector's adaptive capacity and vulnerabilities, as well as critical interdependencies. The team adapted OPDR's Hazard and Climate Vulnerability Assessment Tool, which was created through public and private partnerships, to complete the assessment. The assessment consisted of the following general steps:

- Sector Assessment Part 1: The first step was to assess each sector's adaptive capacity. The team conducted this assessment independent of any particular hazard scenario. To complete the task the team adapted and administered Part 1 of the Vulnerability Assessment Tool to representatives from each sector. The team conducted this phase as part of facilitated meetings with lifeline sector stakeholders, system managers and experts. The team then summarized the information received in the sector report.
- Sector Assessment Part 2: The second step was to assess each sector's hazard sensitivity and potential impacts. The team utilized specific chronic and catastrophic hazard scenarios to inform and direct the discussion. The team worked with the local project lead to select one chronic hazard – flood, and one catastrophic hazard – Cascadia earthquake. To complete this task, the team adapted and administered Part 2 of the Vulnerability Assessment Tool to representatives from each sector. The team conducted this phase as part of facilitated meetings with lifeline sector stakeholders, system managers and experts. The team then summarized the information received in the sector report.
- Sector Assessment Part 3: The team compiled the results and information into a set of sector summaries.

The following subsections are organized as follows: Transportation, water, energy, and communications.

Lifeline Sector: Transportation

Transportation is critical lifeline infrastructure. The transportation network facilitates the movement of people, goods, resources and commerce throughout Marion County and beyond. The transportation system consists of local, state, and federal road and highway networks; passenger and freight rail; passenger and freight air service; pipelines; transit; dedicated bicycle and pedestrian systems; and limited water-based modes. All lifeline sectors depend on the transportation system.

Assessment Snapshot

Table F-1 Transportation Sector Summary

Critical Interdependencies:	Crucial Vulnerabilities:
Systems of all types are dependent on other systems in order to function. In order to operate, the transportation sector is particularly DEPENDENT ON: • Energy and Fuel • Communication • Business and Industry • Public Works **Other critical lifeline sectors that DEPEND ON the transportation sector to operate include:** • Water • Electricity • Liquid fuel • Public Safety and Emergency Management • Public Works • Economy	**Each sector has a number of vulnerabilities. The transportation sector is particularly vulnerable to the following:** • Federal, state and local bridge infrastructure is particularly vulnerable to earthquake (especially ODOT facilities over the Willamette). • System relies heavily on fossil fuels for construction, operation, and maintenance. • Hwy 22 is the primary east-west connection; there are few redundant east-west routes. • Significant backlog of deferred transportation maintenance projects.
Major Findings: • ODOT considers I-5 and Highway 22 to be critical routes. Other critical concerns include bridges, roads, communication, and energy including power and fuel. • Much of the existing transportation infrastructure, including those of major roadways such as I-5, Highway 22, and Mission Road, are not seismically retrofitted and will likely experience structural failures during a Cascadia event. • Following a Cascadia event, transportation will be limited for 6-12 months; aftershocks may extend that timeframe. • Transportation is interdependent with communication, water, and energy systems and requires coordination and collaboration during the response and recovery process. • Although winter storms continue to impact transportation systems, stakeholders respond to these events efficiently and continue to improve plans with every winter weather event. Downed trees, debris, and accumulated ice impact the response of this lifeline.	

- Salem-Keizer Transit operates city and regional buses, dial-a-ride, Cherriots LIFT for people with disabilities and coordinates non-emergent medical transportation services. They provide about 4-million rides a year and are currently working to improve individual employee preparedness as well as existing emergency plans.
- Salem-Keizer Public Schools transports an estimated 22,000 students a day including about 2,000 medically fragile students. The top priority for this organization is student safety.
- The electricity grid in Oregon is not particularly dependent on the transportation sector to operate. However, the power generation and distribution network does rely on the transportation network for construction as well as ongoing maintenance and repairs.
- Conversely, all of the liquid fuel in the state is transported by one of three primary transportation modes: truck, rail, and pipeline. Therefore, the distribution fuel in the state is completely dependent on the transportation sector.
- Like the electric grid, the communications sector is not particularly dependent on the transportation sector to operate. However, the power generation and distribution network does rely on the transportation network for construction as well as ongoing maintenance and repairs.
- Business and industry is very dependent on the transportation sector. From the movement of raw material, to getting employees to and from work, to getting finished products to market, virtually all business and industry activity in the region is facilitated by transportation.
- Public works is dependent on transportation in two primary ways. First, the transportation sector facilitates the movement of equipment, materials, and workers. Second, significant portions or components of public works' infrastructure are collocated within transportation rights of way.

Introduction

Access to means of transportation is fundamental to human existence. Transportation infrastructure facilitates everything from a local trip to the park, drugstore or place of employment to international trade and commerce. Furthermore, the ability to move people, goods and services is vital before, during and after emergency events. It is no accident that FEMA's number one Emergency Support Function is transportation. ESF #1 covers the following:

- Aviation/airspace management and control
- Transportation safety
- Restoration/recovery of transportation infrastructure
- Movement restrictions
- Damage and impact assessment

The scope of ESF #1 includes supporting, ". . . prevention, preparedness, response, recovery and ***mitigation*** activities among transportation stakeholders . . . [emphasis added]" and coordinating, "the restoration of the transportation systems and infrastructure"(FEMA, 2008).

Transportation lifeline sector participants identified a number of interconnected resources and elements of their operations. These include included roads, bridges, buses, and physical buildings. While this assessment focusses on infrastructure, participants noted that transportation staff and professionals are a critical resource as well.

Primary Agencies and Organizations

The following organizations and agencies participated in this assessment:

- City of Salem
- City of Woodburn
- Marion County Public Works
- Marion County Sherriff's Office
- ODOT
- Salem Public Works
- Salem-Keizer School District
- Salem-Keizer Transit
- Woodburn Transit Service

Sector Description

The transportation sector consists of a vast, multimodal network of fixed and mobile public and private assets. This diversity is part of what makes the transportation sector so vital to so many users. However, it is also what makes assessment of the sector challenging.

The primary transportation infrastructure components in Marion County are summarized below followed by more detailed descriptions as provided by the sector participants:

- State and interstate highways: I-5, Hwy 22, Hwy 99, Hwy 214
- County and city road collection and distribution networks. Participants identified eight roads as making up the county's primary collector network: Cordon Road in Salem, Cascade Highway (213), Hillsboro-Silverton Highway (214), Lancaster Drive,

Butteville Road, Jefferson/Marion Road, River Road, Aumsville Highway (connects to prison).
- Bridges, as a critical subset of the city, county, state and interstate road network.
- Public and semi-public transit providers (e.g. Salem Keizer Schools has over 250 school busses, a yard and 56 school drop sites with transit responsibility for roughly 22,000 schoolchildren daily; Salem transit district maintains 56 full size busses and multiple regional busses).
- Passenger and freight rail system: Amtrak operates on the UP line and offers daily passenger rail service through Marion County; Union Pacific, which runs roughly 24 freight trains a day on its line, including hazardous materials; and Portland and Western.
- Fuel and natural gas pipelines
- Two regional airports: Salem municipal airport (includes Oregon Army National Guard – Army Aviation Support Facility) and Albany Municipal Airport and numerous local airports and heliports.
- Two limited capacity ferries: Buena Vista Ferry and Wheatland Ferry

Marion County Public Works

Marion County Public Works identified critical roads for their operation including:

- Corden Road
- Cascade Highway
- Silverton Road
- Hail Prairie
- Butteville Road
- Jefferson Marion Road
- River Road N/S
- Aumsville Highway
- Highway 22
- Highway 99E
- Interstate 5

The City of Salem is the seat of Marion County. Accordingly, it is the main base of operations for Marion County Public Works and has access to backup power. There are three other district buildings, as well as underground fuel storage tanks. The only site that has its own generation capacity to pump fuel is at the North Marion location.

Marion County Sherriff's Office

The Marion County Jail is located on Aumsville Highway. It has backup generation for 36-hours. The Sherriff's Office is also responsible for the continued operation of the Marion County Courthouse. The jail is only served by Aumsville Highway without any redundancy in access.

City of Salem

Arterial streets and bridges are the most critical infrastructure in the City of Salem. The City has jurisdiction over several bridges and there are ODOT bridges that cross the Willamette River. The city identified these bridges as important to accessing West Salem. In the case of an emergency or natural hazard event, the Salem Public Works operations facility has heavy equipment that includes snowplows and dump trucks.

City of Woodburn

Woodburn identified the major roadways Oregon Routes 213, 214, 99E, and U.S. Interstate 5 as key transportation infrastructure. During a hazard event, the City's priority is keeping critical arterials roads open, as well as service collectors to help mitigate traffic flow.

Keizer School District

Keizer School District has a fleet of buses that transports over 20,000 students every day, of which 10 percent have special needs. The school district has 66 traditional school sites and 15 nontraditional school sites and their vulnerable populations are concentrated at their preschool, teen parent site, and alternative school site.

There are 12 support sites and school buses are stored at three facilities located on River Road, Gaffin Road, and Hawthorne Avenue respectively. Each facility has over 200 buses and 10,000 gallons of diesel fuel storage. But, their Hawthorne facility is constructed of poor quality concrete and is not ready for an earthquake. The facilities building has trucks and vans, in addition to refrigerator trucks located at the food service site. Keizer School District relies on a radio dispatch network to communicate with buses out on their routes. It is supported by repeaters and has backup generation capacity, with the intent to switch to a digital cable system.

Lastly, Risk Management staff are continuing to plan for scenarios with the Sheriff's Office and Salem by developing responses for man-made and natural hazard events.

Salem-Keizer Transit

Salem-Keizer Transit has 64 large buses and also operates regional and paratransit buses. The agency is taking steps to have employees prepare at home so that employees can get to work.

The buses run on either diesel or compressed natural gas (CNG). There is a direct connection to the natural gas line, but there is not backup power for pumping natural gas.

ODOT

ODOT considers all state and federal highways as priority roads and in Marion County. However, Highway 22 was identified as being particularly critical as it is the primary east-west connection through the county. ODOT also manages a railroad overpass that has been converted to a non-motorized alternative modes bridge. The bridge is open to runners, cyclists, and pedestrians. Notably, the project provides a critical half-mile link in the bicycle and pedestrian circulation systems for the community, the region, and the state. Moreover, ODOT also maintains a motor pool in Salem and operates its own inter-city transit services and vanpools. It also works with rail, airports, and public transit providers, including Amtrak, which maintains a hub in Salem. Amtrak shares rail lines with freight and while ODOT does not own any stations or lines, it is an important partner in operation for both services.

Highway 22 and Mission Road have structures that are not seismically retrofitted. However, the walking bridge would likely remain a viable alternative for pedestrian and bicycle access across the river after an earthquake. Some ODOT facilities are seismically retrofitted, including ODOT headquarters. ODOT is currently considering an option for a ferry to cross the Willamette River.

ODOT relies heavily on the communications sector and would have difficulty functioning without communications. They do have radio backup capabilities. ODOT identified rerouting must consider overpass availability and has established rerouting of traffic around Interstate 5 using side and city roads. Some facilities, like the Salem Operation Center, may not withstand a Cascadia event. ODOT identified Highway 22 as a critical road as it may be one of the only east-west connections through the cascades.

Adaptive Capacity

Adaptive Capacity refers to a system's ability to accommodate a new or changing environment, exploit beneficial opportunities, or moderate negative effects.

In general terms, the transportation sector has a low level of adaptive capacity. This is primarily due to the large scale and fixed nature of the infrastructure itself. Highways, roads, bridges, airports, and railroads are expensive to construct and not easy to relocate. The political, financial and policy issues related to transportation work as further limits to adaptation. Furthermore, when transportation infrastructure is damaged or otherwise impacted, it takes significant time and investment to fix. Similarly, a huge portion of the sector is completely reliant on fossil fuels to operate. In a state with significant fuel vulnerability, fuel availability becomes a single point of failure for much of the sector even if the physical infrastructure is not impacted. Finally, the entrenched set of sub-sector or mode-specific subsidies, incentives or disincentives pose significant challenges to sector diversification, particularly at the local level.

Interdependencies

Systems of all types are dependent on other systems in order to function. In order to operate, the transportation sector is particularly *dependent on*:

Energy: Electricity and Fuel

The transportation sector is not particularly dependent on electricity. Electricity is needed for traffic signaling and network lighting needs. Further, a small but growing portion of passenger vehicles and some transit modes use electricity. However, these represent a very small percentage of the entire transportation fleet across all modes. The sector is, however, critically dependent on liquid fuel. The vast majority of passenger and freight vehicles, emergency vehicles, aircraft, equipment, and rail all run on fossil fuel. In addition, significant portions of the infrastructure itself consists of fossil fuel derivatives, asphalt being the most notable.

Communication

Transportation is dependent on communication in some modes more than others. Air traffic control, for example, depends on multiple modes of communication to ensure safe air travel. Similarly, passenger and freight rail rely on communications for switching and scheduling. Increasingly, communication systems are used for real-time transportation demand management, traffic control, emergency routing information and trip planning purposes. Finally, communication systems are used to dispatch maintenance crews and to communicate with transportation-related public-safety and law enforcement units.

Business and Industry

The transportation system is heavily reliant on private engineering, design, construction, manufacturing and raw material businesses and industry. Further, most of the vehicles used in transportation are manufactured by private business and industry. Freight rail, commercial air, and pipeline infrastructure is largely owned and operated by private businesses. In short, the transportation sector is critically dependent on private business and industry to operate.

Public Works

Similarly, significant portions of the physical transportation infrastructure are financed, constructed and maintained by the public sector. State and local public works departments are responsible for much of the surface transportation infrastructure in Marion County.

Vulnerabilities

The assessment team evaluated the transportation sector's vulnerability using a scenario planning approach which included one chronic event (winter/ice storm) and a catastrophic event (9.0 Earthquake).

Chronic Hazard: Winter/Ice Storm

Participants indicated that a winter storm could lead to flooding, further compounding damage and harm. ODOT identified that winter storms have significant impacts on their operations as it interrupts emergency, commercial, and personal vehicle capability. In 2014, the mid-Willamette Valley experienced a significant winter storm. ODOT has identified gaps in their response and has planned for future events accordingly. All five ODOT regions have a winter storm plan. There are now also electronic copies, in addition to paper copies.

Keizer School District is also highly sensitive to a winter storm. Decisions around how and when to shelter students or cancel school follow a very specific plan. An area of concern is in regard to bus drivers' hesitance to drive in snow and ice and whether there will be enough drivers and keeping students safe on buses if they are stuck on roads in severe winter conditions. Diesel gelling in extremely cold weather is also a concern for bus operation.

Salem Public Works reported low sensitivity to a winter storm and that their staff and equipment are prepared for this type of event. Their County counterpart, Marion County Public Works, has a yearly test of equipment and staff assignments. Salem-Keizer Transit has a snow plan that facilitates their determination of service capability during a winter storm event.

Catastrophic Hazard: Cascadia Earthquake Event

All participants report extremely high sensitivity to a Cascadia Earthquake with widespread impacts. ODOT in particular reported extreme sensitivity to a Cascadia earthquake event. Much of interstate highway system is not seismically retrofitted and it is likely that Interstate-5 would fail. ODOT has plans to mitigate seismic impacts, but lacks funding to execute.

The Sherriff's Office identified a need to maintain the Courthouse operations and balance law enforcement duties. Of particular concern is moving a population of 3,700 incarcerated individuals if the jail structure is damaged.

Several participants have already begun hazard mitigation and have regular planning meetings. While Salem-Keizer Transit does not have a formal plan, but has begun assessing capabilities and limitations.

Mitigation Opportunities

The transportation sector representatives identified a number of potential mitigation opportunities.

Add Lifeline Corridors to Transportation System Plan

The Marion County Transportation System Plan is "a planning tool that is used to identify transportation projects throughout rural Marion County – this includes roads, transit, bicycles, pedestrians, rails, ferries, freight, and air." In short, it outlines medium- and long-term investments in transportation infrastructure. Although it was recently updated in 2013, the TSP does not specifically identify lifeline corridors or utilize lifeline corridors as a factor in determining TSP project priority. Aligning critical infrastructure mitigation with standard planning activities is one way to better ensure implementation and increase resilience.

Designate Critical Facilities and Employers in City and County TSP

Similar to lifeline corridors, city and county TSPs do not currently include comprehensive assessments of critical facilities and employers. Therefore, transportation investments are not necessarily being targeted to ensuring critical facility and employer transportation access before, during and after disaster events. Integrating hazard mitigation considerations related to critical facilities and employers with standard transportation planning activities is one way to ensure implementation and increase resilience.

Designate Priority Transportation Routes in Marion County

Sector participants highlighted the need to prioritize transportation planning routes in Marion County. The group discussed a "hub and spoke" approach to ensure that resources can be distributed throughout the county from known centralized assembly points (e.g. the Oregon Army National Guard – Army Aviation Support Facility at the Salem Airport). Once routes are prioritized, the county can use that framework to focus transportation related vulnerability assessments (e.g. bridge structural assessments for seismic) and capital improvement plan investments.

Identify Local Funding Sources

While some additional prioritization and integration is warranted, as outlined above, participants also acknowledged that many plans already ID transportation related mitigation projects. These are evident across multiple departments and agencies. Participants identified funding, primarily local sources, as a key barrier to implementation. Participants encouraged efforts to identify local sources of funding to support transportation related mitigation projects.

24-Month Preparation and Outreach Campaign

Participants acknowledged that without increased awareness and preparation, no amount of planning will be enough. The group proposed a targeted and focused 24-month Preparation and Outreach Campaign. The goal of the campaign could be to increase awareness about the vulnerability of the transportation sector in Marion County. Key outcomes could be to increase the level of preparation on the part of citizens, businesses and agencies related to transportation.

Partner with the Marion County Farm Bureau

Participants briefly discussed opportunities to coordinate with the Marion County Farm Bureau on transportation related mitigation projects. The Farm Bureau has not traditionally been a partner in the county's mitigation efforts. However, the Farm Bureau represents a constituency that is highly dependent on access to multiple transportation modes. Collaboration with the Farm Bureau on issues of mutual benefit could be a way to increase awareness and political buy-in.

Lifeline Sector: Water

Water is critical to life. After three days without water, a person will experience severe dehydration, which may lead to death if not reversed. Alone, the intrinsic need for water qualifies the water sector as a lifeline. Water is something our family, friends, emergency personnel, healthcare professionals, and whole community is dependent upon.

Assessment Snapshot

Table F-2 Water Sector Summary

<table>
<tr>
<td>Critical Interdependencies:
Systems of all types are dependent on other systems in order to function. In order to operate, the water sector is particularly <u>DEPENDENT ON</u>:
• Electricity
• Communication
• Transportation
• Liquid Fuel
Other critical lifeline sectors that <u>DEPEND ON</u> the water sector to operate include:
• Fire and EMS
• Business and industry
• Electricity</td>
<td>Crucial Vulnerabilities:
Each sector has a number of vulnerabilities. The transportation sector is particularly vulnerable to the following:
• The water sector in Marion County consists of numerous local and regional systems.
• Several reservoirs, transmission lines and the Salem Treatment Facility are vulnerable to multiple hazards.
• Aquifer storage capacity not sufficient to meet need as a backup source.</td>
</tr>
<tr>
<td colspan="2">Major Findings:
• People living in unincorporated areas of Marion County rely on wells and septic tanks.
• Low water reserves and low river flow pose a serious threat to the water supply.
• Some infrastructure pertaining to water systems are old which increases the risk vulnerability to withstand a Cascadia event. Impacted infrastructure located near rivers could cause service disruptions and flooding during an event or incident. Power is vital to the water facilities.
• Generators are co-located at critical facilities and need to be maintained requiring various fuel types in order to support redundancy.
• Road access is vital to conduct damage assessments and or repair impacted facilities.</td>
</tr>
</table>

Introduction

For the purposes of this assessment, the water sector includes information pertaining to drinking water, stormwater, and wastewater. Stakeholder participants included a range of local and regional infrastructure and service providers. The information provided in this summary is based on research of the county's water resources and infrastructure.

Ready access to virtually unlimited amounts of clean drinking water is often taken for granted, particularly here in the Pacific Northwest. Water is vital for basic daily living, for business and industry especially including agriculture, for fire protection and medical service provision, and for wastewater management. In addition, stormwater facilities provide critical protection from a variety of localized flood risks. FEMA Emergency Support Function #3 covers public works, including water, wastewater and stormwater services. Ensuring that all water related public works infrastructure is operational is critical to the function of any community.

Primary Agencies and Organizations

The following organizations and agencies participated in this assessment:

- Public Works
- City of Stayton
- City of Turner
- City of Salem
- Marion County
- City of Keizer
- North Santiam Watershed Council

The North Santiam Water Council (NSWC) provides resources and knowledge to Marion County. The NSWC is currently working on a Drought Contingency Plan. This will allow the NSWC to better understand the availability and general magnitude of available water resources.

Sector Description

The water sector consists of three primary sub-sectors: drinking water, wastewater and stormwater. Common elements of the drinking water system include source water, intakes, treatment, reservoir storage, transmission, and distribution. Common elements of the wastewater system include collection and treatment. Stormwater systems are primarily collection systems.

Because each jurisdiction has their own infrastructure with similar components additional information specific to each of the participating jurisdictions is included below.

City of Salem

People living in unincorporated areas of Marion County mainly rely on wells and septic tanks.

Marion County Storm and Surface water drainage system includes urbanized East Salem Service District infrastructure, as well as rural roadside drainage ditches. The Service District was established for sewer and lighting, and is now also serving as a stormwater service area. There is a wastewater treatment plant near Keizer. The County Board of Commissioners also serves as the District Board.

City of Aurora

The City of Aurora relies on a groundwater system and the Pudding River to provide access to water. It is located at the end of the Troutdale watershed.

Stayton

Stayton's sanitary sewer, stormwater and water systems are bound within the City limits of Stayton. The City buys water from the Santiam Water Control District and draws water off of a Santiam ditch intake. The City of Stayton also has two wells, which each store enough water for one day. Both of Stayton's drinking water facility and wastewater facility are located near the Santiam River. The drinking water facility used a slow sand filtration system and is currently working on looping the system.

Turner

The City of Turner buys water from the City of Salem. Its water system is capable of serving its 2000 residents and is comprised of two water tanks, two pump stations, 15 miles of pipes, and 200 hydrants. Turner's two water tanks gravity feed the city and are located on a "cliff." Turner also hosts one of Salem's reservoirs.

Salem

As the County seat and capitol of the State of Oregon, Salem plays a significant role in the water sector. The City owns water rights in the North Santiam Watershed and its treatment facility is located on Geren Island, just east of Stayton. Water is conveyed through two large transmission mains to reservoirs, pump stations, and customer taps. There are 17 miles of transmission mains that separate Geren Island from the City of Salem. There are 18 finished water reservoirs. Salem utilizes SCATA, which detects problems in the distribution system. The City of Salem is 70 percent gravity fed and uses a slow sand filtration system to purify its water. The water is also tested upstream. The system is also protected by two valves that are able to isolation sections of the system.

Salem also provides water to three wholesale customers: City of Turner, Suburban East Salem Water District, and Orchard Heights Water Association. The City also operates an Aquifer Storage and Recovery (ASR) system in south Salem. The ASR is replenished in winter rains and stored for the dry days of summer.

Adaptive Capacity

Adaptive Capacity refers to a system's ability to accommodate a new or changing environment, exploit beneficial opportunities, or moderate negative effects.

In general terms, the transportation sector has a low level of adaptive capacity. This is primarily due to the large scale and fixed nature of the infrastructure itself. Highways, roads, bridges, airports, and railroads are expensive to construct and not easy to relocate. The political, financial and policy issues related to transportation work as further limits to adaptation. Furthermore, when transportation infrastructure is damaged or otherwise impacted, it takes significant time and investment to fix. Similarly, a huge portion of the sector is completely reliant on fossil fuels to operate. In a state with significant fuel vulnerability, fuel availability becomes a single point of failure for much of the sector even if the physical infrastructure is not impacted. Finally, the entrenched set of sub-sector or mode-specific subsidies, incentives or disincentives pose significant challenges to sector diversification, particularly at the local level.

Interdependencies

Systems of all types are dependent on other systems in order to function. In order to operate, the transportation sector is particularly ***dependent on***:

Vulnerabilities

The assessment team evaluated the water sector's vulnerability using a scenario planning approach which included one chronic event (winter/ice storm) and a catastrophic event (9.0 Earthquake).

Chronic Hazard: Winter Storm

The drought conditions of 2015 caused great concern and pointedly raised awareness of the water's vulnerability to drought. Low water reserves and low river flow pose a serious threat to the ability to supply water. In addition, with low water levels water quality is of concern. Even with a normal pollutant load, the pollutant concentration will be higher than normal due to the lack of water to dilute.

Winter storms did not pose a high threat to the water sector, but the potential flooding to follow was a major vulnerability. Many of the Cities' infrastructure is located near a river. Flooding could shut down operations creating supply issues. A flood may also wash pollutants into the water sources. However, the predictability of a flood allows for the sector to mitigate and prepare for the hazard event. Lastly, flooded roads and bridges could create an access issue in trying to reach facilities.

Catastrophic Hazard: Cascadia Earthquake Event

Much of the water sector's necessary infrastructure and facilities are old and it is unknown how they will fare in an earthquake event. Some underground transmission lines are over 80 years old and none of the treatment facilities were known to be seismically retrofitted. The location of drinking water treatment facilities and wastewater facilities along riverbanks poses a threat as the soil underneath is subject to liquefaction. If any water supply is available, it will only be used for priority usage including drinking water and water for fighting fires.

The water sector's large uncertainty of how the earthquake will impact their operations parallels their uncertainty of how they will respond and recover. The staff's first reaction will be to secure their own families and then try to find a way to communicate with their colleagues. However, regular communication pathways might be shut down and other options are instead being considered, such as satellite and HAM radio.

Secondly, communities will need to identify points in the system that have been broken, which relies on their ability to access roads and bridges. Currently, supplies, tools, and machinery are not equally distributed throughout the County, which could lead to difficulty in staff accessing and repairing isolated facilities if roads, communications, or energy is inaccessible. Overall, the response and recovery of the water sector will hinge on the ability of staff to access the section of the system needing fixed and having the right resources to fix it.

Wastewater treatment plants pose a health risk. A prime example is the Marion County wastewater treatment plant, just outside of the Keizer city limits. If the Marion County wastewater treatment plant shuts down, the sewage will become backlogged and spill out into the streets of Keizer. This may pose a health and safety hazard, while also potentially contaminating freshwater supplies.

In addition, earthquakes may cause landslides into rivers, causing high turbidity and a potential of high pollutant loads. There are also a number of railroad lines located along river ways, and a hazardous spill that contaminates a relied upon watercourse could result in serious consequences.

Mitigation Opportunities

The water sector representatives identified a number of potential mitigation opportunities. Notably, the need to increase diversity and redundancy were key themes throughout the water sector conversations.

Complete and Implement Drought Contingency Plan

Participants indicated that water quantity will continue to grow as a key issue. Participants acknowledged the work being done to develop a drought contingency plan for the county and applauded the collaborative, multi-agency effort currently underway. The group indicated that completing and moving quickly to implementing the Drought Contingency Plan should be the highest priority for the water sector in Marion County.

Add risk assessment and hazard mitigation information to water master plans

Participants noted that most water master plans do not integrate risk assessment and hazard mitigation strategies. Generally speaking, water master plans outline a program to ensure customers have access to quality drinking water. These include medium- and long-term investments in water infrastructure. Aligning critical infrastructure mitigation with standard planning activities is one way to better ensure implementation and increase resilience.

Increase diversity and redundancy of equipment

Sector stakeholders noted throughout the discussion, that increasing the diversity and redundancy of equipment is critical to the provision of water. Single points of failure, whether at an intake, pump station, or transmission line can take the entire system off-line. Therefore, the group emphasized the need to ensure critical components of the system are backed up.

Increase diversity and redundancy of information

Participants noted that much of the detailed information about water systems is now held in digital or on-line files. Should the electronic system be down or access to electronic files be limited, water system managers would not have access to even basic information about the processing, transmission and distribution systems. Participants indicated that maintaining paper copies of key information and maps should be common practice.

Develop a pre-determined "shut down" process, procedure and prioritization

If multiple systems need to be shut down, the county does not currently have a good understanding of the order and priority. The group discussed the need to predetermine a process, procedure and prioritization scheme. As part of this effort, determining points of contact and communication protocols is important.

Continue to evaluate infrastructure mitigation opportunities

Participants outlined several examples of water infrastructure that is old, out of date. In other cases, participants cited partial progress on resilience where additional investments are still needed.

Lifeline Sector: Energy

The energy sector is critical to modern life. Electricity is vital for virtually all household, business and emergency operations; liquid fuel is used for transportation, facility construction and repair, and backup power; natural gas is used for electricity generation, heating, cooking, powering vehicles, and other uses. The resilience, redundancy, and interdependencies of the energy sector will largely determine the timeline for emergency response and long-term community recovery. Diverse and redundant energy supply and distribution can significantly increase regional resilience.

Assessment Snapshot

Table F-3 Energy Sector Summary

<table>
<tr>
<td>Critical Interdependencies:
Systems of all types are dependent on other systems in order to function. In order to operate, the communication sector is particularly <u>DEPENDENT ON</u>:
• Transportation
• Communication
Other critical lifeline sectors that <u>DEPEND ON</u> the communication sector to operate include:
• Public Safety and Emergency Management
• Transportation
• Water
• Communication
• Economy</td>
<td>Critical Vulnerabilities:
Each sector is vulnerable to a variety of impacts. The energy sector is particularly vulnerable to the following:
• Consumption consists almost entirely of one of three forms: electricity, liquid fuels, natural gas.
• Dependence on BPA for electric power; Marion County produces very little power locally.
• Lead time for ordering critical system components (e.g. transformers)
• Concentration of liquid fuel storage facilities in Portland; limited local fuel storage and supply.
• Lack of capability to pump fuel locally without power.
• Reliance on supply and distribution facilities located outside Marion County.</td>
</tr>
<tr>
<td colspan="2">Major Findings:
• Generators are co-located by equipment and are used at critical infrastructure throughout the county; however, require various fuel types depending on the unit.
• Oregon’s fuel storage facilities are located in Portland and are susceptible to failure due to soil liquefaction. The storage capacity on a normal day is six days; therefore, it is anticipated that fuel will be an undersupplied commodity during a Cascadia event. It will take 3-6 weeks to reacquire fuel.
• Energy is critically interdependent with the transportation, communication, and water sectors. For example, not having access to roads nor having the ability to communicate with responders leaves the energy sector extremely vulnerable. In addition, there is a need for energy in powering water treatment plants. These vulnerabilities are particularly heightened in areas where accesses via bridges or singular roads are susceptible to failure.
• The EPA regulates energy in terms of emissions limiting the capacity to produce additional energy resources.</td>
</tr>
</table>

- Damage assessments will be critical to capture the impacts to this lifeline. Downed trees, accumulating ice, and high winds can impact the resiliency of energy as a lifeline.
- The energy sector also prepares and mitigates against human-made disasters, such as cyberattacks.
- The energy sector grants people with uninterrupted services due to medical status during non-catastrophic events.
- An estimated 1-3 months of electrical service interruption during a Cascadia event.

Primary Agencies and Organizations

The following organizations and agencies participated in this assessment:

- Pacific Gas and Electric (PGE)

Sector Description[21]

The energy sector is one of the most crucial lifelines in Marion County, providing electricity, liquid fuel and natural gas to residents and businesses from Aurora to Stayton and Salem to Idanha. Energy supports a wide array of community needs from charging cellphones to powering lifesaving medical equipment. Furthermore, other lifeline sectors rely on energy to provide many basic services. The resilience of this sector in a natural hazard event will greatly influence response capabilities. Furthermore, post-event recovery operations and success will depend in large part on the length of time it takes the energy sector to come back on line.

Electricity

The electric sector in Marion County is comprised of two local providers (Salem Electric and Pacific Power), and a federal power agency (Portland General Electric (PGE)). These three companies provide electricity to over 300,000 people in Marion County. Electric facility construction and maintenance is a key component of this sector's responsibility. The local agencies are primarily responsible for the distribution of electricity to residential, commercial, industrial and institutional customers. The vast majority of electricity generation is provided by the Bonneville Power Administration (BPA). Their resiliency and ability to respond in a hazard event is vital to reestablishing other important lifelines and facilities. For the purpose of this analysis, the information included primarily pertains to PGE, which is the largest distributor of electricity in Marion County.

PGE's critical infrastructure is located throughout Marion County and the larger Willamette Valley region. Currently, all of PGE's major hydroelectricity facilities are located outside of Marion County, in Timothy Lake, Clackamas River, and Estacada. Most of Oregon's liquid fuel is stored in reserves along the bank of the Willamette in the Portland Metro area. Notably, PGE maintains a local critical facilities list that consists of key emergency response, industry and public agency partners.

Participants emphasized that the sector is actively working to increase the diversity and redundancy of local electricity supply and distribution through a number of innovative

[21] Due to limited stakeholder involvement, portions of this section are informed by the City of Salem Local Energy Assurance Plan and the Marion County Commodity Flow Study.

projects. The Salem Smart Power Center, hosted by PGE, is intended to be the hub of "one of the most advanced electrical systems in the country" (Portland General Electric). Consisting of a 5-megawatt lithium-ion battery and inverter system, the Smart Power Center is intended to provide backup power to the regional grid. In conjunction with this project, the sector is working on a number of additional "micro-grid" projects. To date, the sector has identified seven potential sites micro-grid throughout the county. One of those sites, located at the Oregon Department of Public Safety Standards and Training facility in Salem, is currently being explored as a pilot project. Additionally, the sector is evaluating distributed satellite generation (DSG) siting opportunities throughout the region. Collectively, the vision for these electric supply and distribution projects is to create a "triangle of control" that significantly increases local electricity resilience.

Liquid Fuel

The petroleum supply chain consists of extracting crude oil, transporting it to refineries, processing it into petroleum products, and finally transporting it to consumers, often via intermediate suppliers. After being extracted, crude oil is refined into a number of petroleum products, including:

- Motor fuel, primarily gasoline;
- Distillate fuel, including diesel fuels, industrial fuels, and heating fuels;
- Liquefiable Petroleum Gas, including ethane, propane, butane, and others;
- Jet fuel, used in aircraft engines;
- Residual fuel oil, a by-product of the refinement process often used to produce heat or electricity; and
- Other products such as asphalt, kerosene, and lubricants.

According to the Oregon Resilience Plan, over 90% of Oregon's liquid fuel supply originates in the Puget Sound area in Washington. All of that fuel passes through the Critical Energy Infrastructure Hub north of Portland before it is distributed throughout the state. Marion county has limited liquid fuel supply reserves. According to the Salem Energy Assurance Plan, the Salem area has roughly 2.5-3.7 million gallons of fuel storage capacity. Assuming an average fuel storage volume, this equates to between three- and five-days of fuel availability.

Natural Gas

The primary natural gas supply chain consists of the extraction and processing of natural gas; the transportation of that gas via pipeline; and the underground storage or direct use of the gas for heating, fuel, electricity generation, or other uses. Approximately one in three Oregonians rely on natural gas as the primary source for heating their homes, according to the U.S. Energy Information Administration's State Energy Data System. Oregon produces no natural gas of its own and must import its entire supply from out-of-state. Oregon's natural gas is produced in British Columbia, Alberta, Wyoming, Colorado, and New Mexico, and is transmitted to Oregon via an interstate pipeline system.

Marion County has two major gas transmission pipelines. Distribution lines are located throughout the county.

Summary Considerations:

- Oregon imports 100 percent of its petroleum and natural gas, but generates most of its own electricity.

- Salem generates almost no electricity, and over half of its electricity supply is dependent on fossil fuels.
- Local generation and storage of electricity through on-site generators, solar panels, fuel cells, battery arrays, and other technologies can provide a way for individual facilities to diminish their vulnerability to electrical supply disruptions. Adoption of these technologies is far from universal; a widespread or long-term electrical outage would likely have severe consequences.
- The Puget Sound refineries provide more than 90 percent of Oregon's refined petroleum products, and it operates at about 95 percent capacity.
- About one-third of Oregonians residents use natural gas for heating, and Salem's natural gas supply is dependent a on a single pipeline.
- Salem depends on the road network for deliveries of petroleum products, and for deliveries of liquefied natural gas (LNG) if the natural gas network is disrupted. A petroleum pipeline travels through Salem but has no outlet there.

Vulnerabilities and Risk Assessment

The energy sector's vulnerability was assessed through scenario planning, which included a chronic event and a catastrophic event.

Chronic Hazard: Winter/Ice Storm

The energy sector has fared well in recent winter storm events. On its own, a winter storm poses risk, but the negative impacts are often geographically isolated, limited to the electricity, and easily recovered from. For example, a winter storm might bring freezing rain, sleet, and ice which accumulates on tree branches, causing them to break and possibly damage power lines. Flooding as a result of snow melt poses a potential risk primarily due to impacts on the transportation system.

Damaged transportation infrastructure or the potential for limited road access in the event of a winter storm is the energy sector's primary vulnerability. Transportation access is particularly a concern in rural areas that are accessible via bridges or singular roads. Energy providers must coordinate with transportation departments and public works crews to ensure roadways are passable prior to responding to damage or power outages.

Overall, energy sector recovery occurs relatively quickly during winter storm events as there are established protocols, trained personnel and equipment needed to respond and adapt to the event.

Catastrophic Hazard: Cascadia Earthquake Event

Currently, the energy sector is extremely sensitive to a Cascadia subduction zone event or other large local earthquake. Energy infrastructure and facilities are highly sensitive to violent shaking and liquefaction. Notably, significant portions of Marion County are susceptible to liquefaction during a large magnitude earthquake. An event of this size is expected to have significant impacts to all energy transmission, distribution, and storage facilities. The unpredictability of the Cascadia event stems from the inability to properly estimate individual facility impacts. As a result, the energy sector must work towards establishing hazard mitigation, infrastructure resilience, and coordinated response efforts that anchor their ability to provide service. The following vulnerabilities demonstrate points of weakness and opportunities for mitigation within the energy sector.

First, damaged transportation infrastructure or the potential for limited road access in the event of a Cascadia earthquake leaves the energy sector extremely vulnerable. This is particularly a concern in rural areas that are accessible via bridges or singular roads. Some of these roads and bridges are not seismically sound, or are located in areas that would be difficult to get supplies and repair vehicles and personnel to.

Marion County lacks energy independence; it is reliant on hydroelectric power, liquid fuel, and natural gas inventories that are supplied from outside of the County. Generators can be used in an emergency event. However, these depend on fuel to run. As a result of Oregon's current practices for storing fuel, a large earthquake event will lead to drastically lessened access to fuel. It is highly likely the fuel supply will be significantly limited and prioritized for emergency response and recovery following an event.

Mitigation Opportunities

The energy sector assessment identified several potential mitigation opportunities.

Compare, crosswalk and maintain critical facilities lists

BPA, Marion County and other state and local partners maintain lists of critical facilities. Some agencies prioritize those critical facilities for emergency response and recovery resources, including electricity and other energy sources. Participants expressed a desire to compare and coordinate those critical facilities lists to ensure consistency.

Develop and maintain a "no-disconnect" list

At present, electric and natural gas utilities disconnect service after periods of non-payment. Vulnerable populations, particularly those that require electricity for medical equipment, can be placed a significant risk if service is disconnected. Developing a strategy to ensure that critically vulnerable populations are not disconnected from electrical service, even if they are unable to pay for service, is needed.

All-hazard risk assessment for critical energy infrastructure

Stakeholders indicated that additional risk assessment information is needed across a range of hazards and infrastructure sectors. Specifically, there is a desire for a "bulk upload spreadsheet" where assessment information can input.

Source additional funding for tree trimming projects

Participants acknowledged that additional funding is needed for hazard-tree trimming projects. Because power outages disproportionately impact vulnerable populations, these funds should be prioritized for improving electrical system resilience for vulnerable populations.

Innovation project: Utilize used batteries tied to solar generation for backup power

Sector participants discussed how innovation could be used to increase local or micro-energy resilience. One participant observed that forklift, golf-cart and other batteries are often replaced prior to the end of their useful life. Batteries of this size are capable of storing significantly more power than smaller car batteries. This project would assess the feasibility of utilizing used industrial batteries for backup power.

Lifeline Sector: Communication

The communication sector facilitates the rapid exchange of information across a broad range of systems and technologies. These include: broadcast television and radio, telephone, cellular phone, cable, internet, two-way radio, and Ham (or amateur) radio.

Assessment Snapshot

Table F-4 Communication Sector Summary

Critical Interdependencies:	Critical Vulnerabilities:
Systems of all types are dependent on other systems in order to function. In order to operate, the communication sector is particularly <u>DEPENDENT ON</u>: • Electricity • Energy (fuel) • Transportation **Other critical lifeline sectors that <u>DEPEND ON</u> the communication sector to operate include:** • Water (SCADA) • Electricity • Public Safety and Emergency Management • Transportation • Economy	**Each sector is vulnerable to a variety of impacts. The communications sector is particularly vulnerable to the following:** • All systems rely on electricity for operation and maintain generators for backup power. Generators rely on fossil fuels to operate leading to questions about what systems and services would be prioritized for gasoline/diesel fuel use if there were a disruption to fuel supply. Also, some generates operate on propane or natural gas, neither of which are included in state or federal energy assurance plans. • All systems rely on infrastructure (towers, antennae) spread across large areas, often in remote locations. Road access to repair equipment is a primary concern • 911 service and other emergency communication relies on line-of-site microwave transmission. Even small changes in antennae alignment can disrupt transmission and require recalibration to re-establish connections between towers. Fiber infrastructure is vulnerable to earthquake damage, in particular where lines are connected to bridge spans.

Major Findings:

- Many providers share infrastructure and or have their infrastructure co-located.
- Stakeholders are well prepared to address winter storms and other disasters as long as there is access to their facilities. Transportation, water, and energy are equally dependent on communication infrastructure. In addition, trees, wind and ice are hazards that can impact this lifeline.
- During a power outage, battery and generator backups provide limited power for a varying duration of time depending on the fuel source and capacity. Redundancy is a needed resource for critical infrastructure that requires access and the supply of multiple fuel types, primarily gasoline and diesel. Notably, propane is a fuel source for some generators; however, propane will not be provided through state resources. Some generates operate on propane or natural gas, neither of which are included in state or federal energy assurance plans.
- All providers anticipate a 75-100% shut-down after a Cascadia event. Due to the roads and bridges being impassable, network connections could be severed.
- Largest barriers to respond in a Cascadia event include: staff ability to respond, access to facilities, shortage of supplies to repair infrastructure, time, funding, and political support.
- Stakeholders recognize that their staff and families need to be prepared. To address this need, they are supporting a proactive approach to disasters. In particular, the Communications sector is working to train employees to be prepared for disasters so they can address their own immediate needs before safely addressing the needs of the sector post-event.
- Some towers have fiber optic lines as a redundancy. However, these lines are vulnerable in a catastrophic earthquake, in particular where lines are connected to bridge spans.
- Water infrastructure systems rely on communication for operations and maintenance through a “Supervisory Control and Data Acquisition” (SCADA) system. The system provides remote monitoring and control of the water system components. Radio system capability is needed for these systems to operate effectively. Much of this infrastructure is isolated. For example, Salem’s infrastructure is located on an island.
- Amateur Radio provides critical back up to public safety radio communications in a disaster, but does not provide the necessary capacity to meet emergency management needs. Jurisdictions should consider investing in satellite voice and data capabilities.
- Local servers may be damages in an earthquake. Jurisdictions should consider "cloud based" data storage solutions to backup vital records.

Introduction

Communication is an essential aspect of virtually all public and private sector activities. The ability to communicate is especially critical during an emergency. Notably, FEMA's Emergency Support Function #2 – Communications specifically supports the restoration of communications infrastructure. The scope of ESF #2 includes "restoration of public communications infrastructure" and assisting "State, tribal, and local governments with emergency communications and restoration of public safety communications systems and first responder networks." (FEMA, 2008)

This assessment focusses on (1) the adaptive capacity of the communications sector, (2) hazard-specific vulnerabilities to communication infrastructure, and (3) mitigation opportunities that can support uninterrupted or rapid restoration of communication capability during or following emergency or disaster event.

Primary Agencies and Organizations

The following organizations and agencies participated in this assessment:

- Capital Community Television (CCTV)
- Amateur Radio Emergency Service (ARES)
- Marion Area Multi-Agency Emergency Telecommunications Dispatch Center (METCOM 911)
- Santiam Canyon Phone
- Willamette Valley Communications Center (WVCC)
- Frontier
- Verizon
- Oregon Statewide Inoperability Coordinator (SWIC)
- Service Master of Salem
- Pacific Gas and Electric Company (PGE)

Sector Description

The communication sector consists of many primary infrastructure components, including microwave and radio frequency antennas, cable and fiber optic lines, routers, switches, and more.

Many communication providers share infrastructure, poles and lines, or have their infrastructure collocated. Additionally, energy providers often share poles and wires with communication providers. While local private-sector communication providers often have emergency response agreements with their national or parent organization (e.g., Frontier and Verizon) most public sector communication providers (e.g. ARES and METCOM 911) have to maintain and repair their own networks in the event a hazard disrupts service.

A point heavily emphasized to the project team, particularly by WVCC, which dispatches and maintains communication links for 29 different agencies throughout Marion County, is that their entire network is connected through microwave transmission. This infrastructure relies on networks of relay stations that require line-of-site connections to operate. Therefore, a single point failure resulting from a loss of relay station alignment could mean that a large portion of the network is down until the facility can be accessed and repaired.

Additionally, some communication providers have systems that rely on selective routing. This means that their cell towers send signals to an electric router in Portland and then back to Marion County. The providers who use this method have limited control over this portion of the process until it reaches their facility. For those who use or can access C4 routing, 80 percent of the calls are wireless.

The HAM/amateur radio network (ARES) utilizes VHF/UHF technology. VHF/UHF utilizing a repeater enables communication ranges of 100+ miles; HF facilitates communication from 100+-3000+ miles w/o a repeater. There are 100 or more repeaters across the state, which are managed through the State Repeater Coordinating Council, an independent HAM radio body. The channels are open and are non-secure. However, the HAM radio network can establish repeater sites, which allow the portable network to link over hills and create a statewide network that can be linked remotely with radio. These radio repeaters are often collocated with 911 towers and have a battery life of six to twelve hours. Some operators have cross band repeaters, which can extend their communication range anywhere from three to forty miles, depending on where repeaters are placed. HAM radios can also use digital signals and non-voice communication, which sends information in a format similar to email. At this moment, there is a long waiting list for volunteers to access a limited number of frequencies. Locations and frequencies are managed on a first come, first serve basis through the State Repeating Coordinating Council.

Adaptive Capacity

Adaptive Capacity refers to a system's ability to accommodate a new or changing environment, exploit beneficial opportunities, or moderate negative effects.

In general, the communications sector exhibits a high degree of adaptive capacity. This is primarily the result of the diverse and redundant nature of communication infrastructure. For example, sector stakeholders indicated that much of the communication equipment is redundant across the system. Further, many of the systems components (e.g. towers, switches, etc.) have both primary and secondary power sources. This facilitates signal rerouting when needed. Further, the mix of deployed technologies, public and private sector vendors, and redundant equipment all contribute to the sector's ability to adapt to a range of potential impacts.

Within specific geographic areas (such as the Santiam canyon) or infrastructure components (e.g. cable), some adaptive capacity is lost. Participants reported that this is primarily due to single points of failure or lack of redundant equipment.

System Vulnerabilities

The assessment team evaluated the communication sector's vulnerability using a scenario planning approach which included one chronic event (winter/ice storm) and a catastrophic event (9.0 Earthquake).

Interdependencies

Systems of all types are dependent on other systems in order to function. In order to operate, the communication sector is particularly *dependent on*:

Energy: Electricity and Fuel

Communication equipment requires power to operate. If the power grid is down and backup power is not available through generators, batteries or other sources, system components will not function. During a power outage, battery and generator backups provide limited power for a varying duration of time depending on the fuel source and capacity. Energy redundancy is a needed resource for critical infrastructure that requires access and the supply of multiple fuel types, primarily gasoline and diesel. Notably, propane is a fuel source for some generators; however, propane will not be provided through state resources.

Transportation

Sector stakeholders indicated that if they can get repair crews, equipment and power to their system components, they can generally restore service quickly. However, many system components are located in remote locations with limited access under normal circumstances. Any disruption to the transportation network can limit or delay restoration of the communication network. Further, where communication infrastructure is collocated within the transportation network (e.g., buried cable within a road right-of-way), damage to the transportation facility can disrupt communication service.

Water

Water infrastructure systems rely on communication for operations and maintenance through a “Supervisory Control and Data Acquisition” (SCADA) system. The system provides remote monitoring and control of the water system components. Radio system capability is needed for these systems to operate effectively. Much of this infrastructure is isolated. For example, Salem’s infrastructure is located on an island.

Vulnerabilities

Chronic Hazard: Winter/Ice Storm

Many stakeholders indicated that they are well prepared to address winter storms. Winter storms are common in the region and communication providers have significant experience maintaining and repairing infrastructure during such events. Further, the Communications sector actively mitigates storm related impacts through ongoing risk reduction actions. For example, communication service providers often partner with utility providers to trim trees near above-ground communication lines. Downed trees were also a concern and therefore, monitoring tree health and stability is a part of this maintenance program.

Another factor that may affect addressing the impacts of a winter storm on service is the ability of communication agencies to access critical facilities and infrastructure via roads. While this is a minor concern, as Marion County Public Works has a number of snow plows and snow cats, many communications providers recalled the 2008 winter storm in which Interstate 5 was largely inaccessible. However, this can be remedied by the ability to take alternative routes and if necessary, using snow chains or snowmobiles to access sites. That being said, residents of Marion County who live in rural areas may experience communications outages for up to a week until utility providers can repair their systems.

Power disruptions are also a concern for this sector because their ability to deliver service and respond to emergencies is contingent on consistent access to power. If the power goes out, there is limited battery backup and available generators, which could generate power for up to ten hours. For example, Frontier stated that while rural facilities have batteries, they do not have portable generators and teams must travel to those facilities to deploy emergency generators. Yet, many providers have disaster checklists and train their staff on how to implement their internal and external crisis communications plans. Their reaction depends on the size of the storm and providers have the capability to scale up or down as needed. Additionally, restoring communications is prioritized based on the importance of the infrastructure. Ensuring hospitals, police and fire departments, and other critical community assets have access to communications is prioritized over restoring residential communications.

Another concern in regard to a winter storm is that those who work for communications providers may not live nearby and therefore could have trouble getting to work. This means that these providers may be working with limited staff, making it more difficult to restore and maintain operations. Although some providers do require their staff to have emergency kits at home, this is implemented on an ad hoc basis.

Catastrophic Hazard: Cascadia Earthquake Event

There was overwhelming consensus that the communication sector in general is not adequately prepared for a Cascadia earthquake event. Many expressed a range of concerns, including:

- "The State of Oregon is unprepared. DOGAMI mentions almost every bridge and road. Salem does have several mobile-com centers, which is the only positive."
- "Nobody knows. It depends on how devastating [Cascadia is]."
- "It would cost millions to replace the system. Equipment replacement would be costly and would take weeks to acquire the necessary replacements."
- "We have a lack of redundancy in the communication system. There is a time delay to activate backup systems and we have a training deficiency."

Every provider and agency in the meeting is anticipating a 75 to 100 percent shutdown in operations in the event of a Cascadia earthquake. While many are taking steps to prepare for Cascadia, these efforts are slow moving and limited by a variety of factors. Steps that have been taken or are being taken to reduce vulnerability to a Cascadia earthquake event include:

- Plans for system improvements to infrastructure over next fifty years
- Establishing similar timing and synchronism with other sectors
- Developing a standard set of planning assumptions
- Implementing a system for fuel coordination with other communications agencies and ensuring that sites have an emergency fuel supply
- Each entity will take on the responsibility of re-establishing a priority system or infrastructure piece

The biggest barriers for adequately responding to a Cascadia earthquake event include:

- Lack of regulations and decision-making protocol,
- Funding for operations and maintenance (particularly for public systems),
- Access to capital for mitigation activities, and
- Political will to prioritize mitigation activities.

While there are limited state and federal resources, these are not always readily accessible or easy to obtain due to availability or priority.

One of the largest concerns raised by the group was the lack of coordination across the sector. The mix of public, private, and volunteer entities compounds the issue. Sector participants indicated that there are very few conversations focused on building partnerships and relationships within the communications sector. For many, the sector meeting was the first time they had met or talked to representatives from other agencies, companies or groups. The group agreed that coordinated partnership building and collaboration will be necessary in order to mitigate hazard impacts across the sector. This is particularly true in the case of planning for a Cascadia earthquake event. Building partnerships also provides an opportunity to pool resources and potentially labor, especially since many of the agencies and organizations that were interviewed have collocated facilities.

Another concern was the ability to maintain service in the event of a hazard. Many discussed the importance of determining how to access locations that are blocked in the event of a hazard; how to maintain critical service connections, particularly after a catastrophic event; how to get signals out if landlines are disrupted; and, how to get labor from facilities and out to citizens. Further, sector representatives anticipate that they will experience staff shortages following an event.

Other concerns included education and outreach, particularly on educating the public on what is an emergency and what isn't. Moreover, organizations, such as ARES, struggle with recruiting new volunteers and training individuals on HAM radio operation. Additionally, while they do have a volunteer base, they lack equipment.

Mitigation Opportunities

The communications sector representatives identified a number of potential mitigation opportunities.

Joint Utility Liaison

Sector representatives indicated that creating a Joint Utility Liaison position could be an important first step in promoting coordination. The purpose of the position would be to share information across sector providers and coordinate regular meetings. Many representatives indicated that the primary value of the risk assessment process was the simple act of sitting down together to discuss the issues – system vulnerabilities, mitigation priorities and lessons learned. However, the group noted that "meeting for the sake of meeting" would not be productive. Further, the group indicated that regular coordination was unlikely without a person dedicated to coordinating sector stakeholders and facilitating the discussion. The group expressed support for a quarterly meeting schedule.

This action was deemed a high priority by the communication sector participants. When this action is implemented with the communication sector, CPW recommends instituting a facilitation approach such as the Purdue University "Strategic Doing" model.[22] Strategic Doing, "teaches groups how to form collaborations quickly, move them toward measurable outcomes and make adjustments along the way." The model is intended to design and guide networks that generate innovative solutions. With Strategic Doing, people:

- Link and leverage their assets to create new opportunities
- Convert high-priority opportunities into measurable outcomes
- Define pathfinder projects that move toward these outcomes

[22] Strategic Doing is, "a new strategy discipline specifically designed for open, loosely-connected networks. Unlike strategic planning that was designed primarily to guide strategic activity in hierarchical organizations, Strategic Doing is designed for situations in which nobody can tell anybody else what to do. Collaboration is the only way to move forward."

In short, the Strategic Doing is designed for open, loosely connected networks like what currently exists within the communications lifeline sector in Marion County.

Special Communication District

Because funding was cited as an issue (particularly for public agency representatives) some stakeholders suggested exploring the feasibility of a Communication District. The purpose of the district would be to generate funds needed for ongoing system maintenance, equipment modernization and hazard mitigation activities (such as site hardening, redundant power supplies and training).

FirstNet Resources

Signed into law as part of the February 22, 2012 Middle Class Tax Relief and Job Creation Act, the First Responder Network Authority (FirstNet) has a mission to, "build, operate and maintain the first high-speed, nationwide wireless broadband network dedicated to public safety." The FirstNet vision is to provide a single interoperable platform for emergency and daily public safety communications. Marion County communication sector representatives support mitigation actions that leverage FirstNet funding to support the "hardening" of local communication infrastructure. This approach would meet FirstNet's task to leverage existing telecommunications infrastructure and assets. The approach also includes the exploration of public/private partnerships, which is consistent with the Joint Utility Liaison approach advocated above.

Leverage Department of Energy Clear Path IV Exercise and ESF 12

The Department of Energy is facilitating a series of exercises across the nation to address hazard impacts and other challenges to the energy sector. Because the communications sector is so heavily dependent on electricity and fuel (primarily gasoline and diesel), stakeholders indicated that participation in the Clear Path IV Cascadia Subduction Zone (CSZ) exercise could help focus attention on needed public/private sector collaboration.

UPDATE: ClearPath IV occurred April 19-20, 2016. Marion County participated directly in the exercise. While communication sector stakeholders are not specifically listed in the exercise participant list, one on the key recommendations includes improved coordination with, "agencies and organizations providing critical services in support of energy restoration." (U.S. Department of Energy, 2016)

Training

Participants identified the need for additional training of staff and personnel. In some cases, there are limited numbers of technicians with the expertise needed to repair specific communication components. Further, the number of HAM operators is declining. Finally, fewer young people are entering the communication trades. Stakeholders expressed a need for additional training of the existing workforce, as well as the need to encourage new interest in the industry.

Coordinate Planning Assumptions

Communication sector stakeholders indicated that agreement about hazard planning assumptions is needed. While there was general consensus about the range of vulnerabilities across the sector, assumptions about specifics varied. Stakeholders identified energy availability (including fuel), staff/personnel availability, and infrastructure impacts as potential planning topics that could benefit from shared understanding for planning purposes.

Networks

The primary theme in the assessment of the communication sector was the critical importance of networks. Because of the interconnected nature of communication technology and the sector's reliance on energy and transportation, as well as its critical importance to the water system, developing and maintaining relationships was identified as a critical strategy. Stakeholders reinforced the importance of pre-event relationship building. This can only occur through regular interaction, common operating assumptions and co-production of strategy options. Using a State Homeland Security Grant, Marion County will develop a Marion County Communications Plan in FY17-18. This planning will provide an opportunity to develop a comprehensive strategy to build capability and mitigate vulnerabilities as well as sustain further stakeholder engagement.

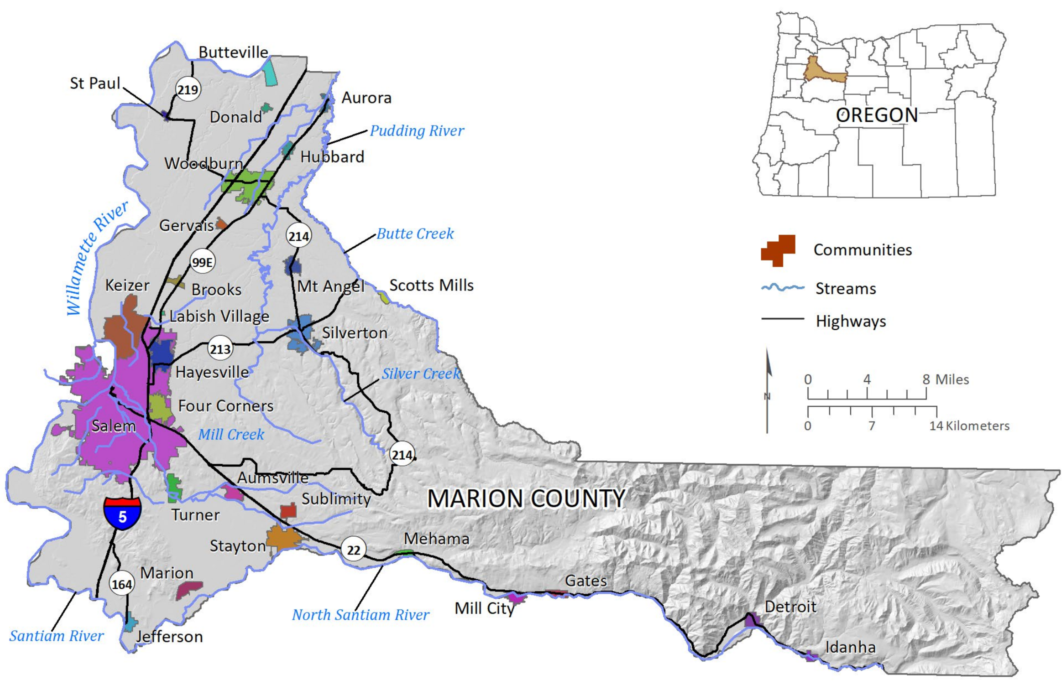
APPENDIX G: DOGAMI MULTI-HAZARD RISK REPORT FOR MARION COUNTY, OREGON

State of Oregon
Oregon Department of Geology and Mineral Industries
Ruarri Day-Stirrat, State Geologist

OPEN-FILE REPORT O-22-05

MULTI-HAZARD RISK REPORT FOR MARION COUNTY, OREGON

INCLUDING THE CITIES OF AUMSVILLE, AURORA, DETROIT, DONALD, GATES, GERVAIS, HUBBARD, IDANHA, JEFFERSON, KEIZER, MILL CITY, MT. ANGEL, SALEM, SCOTTS MILLS, SILVERTON, ST. PAUL, STAYTON, SUBLIMITY, TURNER, AND WOODBURN AND THE UNINCORPORATED COMMUNITIES OF BROOKS, BUTTEVILLE, FOUR CORNERS, HAYESVILLE, LABISH VILLAGE, MARION, MEHAMA, AND WEST SALEM



by Matt C. Williams and Ian P. Madin

2022

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Cover image: Study area of the Marion County Risk Report. Map depicts Marion County, Oregon and communities included in this report.

WHAT'S IN THIS REPORT?

This report describes the methods and results of natural hazard risk assessments for Marion County communities. The risk assessments can help communities better plan for disaster.

Oregon Department of Geology and Mineral Industries Open-File Report O-22-05
Published in conformance with ORS 516.030

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Appendix E

GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA

See the digital publication folder for files.
Geodatabase is Esri® version 10.7 format. Metadata are embedded in the geodatabase and are also provided as separate .xml format files.

Marion_County_Risk_Report_Data.gdb

Feature dataset: Asset_Data
feature classes:
Building_footprints (polygons)
Communities (polygons)
UDF_points (points)

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 the communities of Marion County, Oregon, with funding provided by the Federal Emergency Management Agency (FEMA). It describes the methods and results of the natural hazard risk assessments performed in 2021 and 2022 by the Oregon Department of Geology and Mineral Industries (DOGAMI) within the study area. The purpose of this project is to provide communities with detailed risk assessment information to enable them to compare hazards and act to reduce their risk. The risk assessments contained in this project quantify the impacts of natural hazards to these communities and enhances the decision-making process in planning for disasters.

We arrived at our findings and conclusions by completing three main tasks for each community: compiling an asset database, identifying and using the best available hazard data, and performing natural hazard risk assessments.

- In the first task, we created a comprehensive asset database for the entire study area by synthesizing assessor data, U.S. Census information, FEMA Hazus®-MH general building stock information, and building footprint data. This work resulted in a single dataset of building points and their associated building characteristics. With these data we were able to represent accurate spatial locations and vulnerabilities on a building-by-building basis.
- The second task was to identify and use the most current and appropriate hazard datasets for the study area. Most of the hazard datasets used in this report were created by DOGAMI and were produced using high-resolution, lidar 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.
- In the third task, we performed risk assessments using Esri® ArcGIS Desktop® software. We took two risk assessment approaches: (1) estimated loss (in dollars) to buildings from flood (recurrence intervals) and earthquake scenarios using the Hazus-MH methodology, and (2) 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, wildfire, and volcanic lahar.

The findings and conclusions of this report show the potential impacts of hazards in communities within Marion County. Earthquakes: Although earthquake damage will occur throughout the entire county, extensive damage and losses are more probable in the northeastern portion of the county near the Mt. Angel Fault and areas with liquefaction-prone soils. Our findings indicate that most of the critical facilities in the study area are at High risk from an earthquake. We used multiple Hazus-MH earthquake simulations to illustrate the potential reduction in earthquake damage through seismic retrofits. Flooding: Some communities in the study area have moderate risk from flooding and we found only a small percentage (<1%) of flood exposed buildings were elevated above the 100-year flood elevation. Landslides: Our analysis shows that areas with moderate to steep slopes or at the base of steep hillsides are at greatest risk from landslide hazards, such as along the North Santiam River, the communities of Mt. Angel and Scotts Mills, and southwestern portions of Salem. Channel migration zone hazards: Nearly 826 buildings along the Pudding River and Santiam and North Santiam Rivers were exposed to channel migration hazard. Wildfires: The wildfire hazard data used in this study were created prior to the unprecedented 2020 Labor Day Wildfires, however the results corresponded to the actual impacts of the 2020 Labor Day Wildfires in the county. Volcanic-lahar hazards: Lahar hazard is a potential risk and could have significant impact for areas and the communities along the North 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.

Results were broken out for the following geographic areas:

- Unincorporated Marion County (rural)
- Community of Hayesville
- Community of Brooks
- Community of Marion
- City of Aumsville
- City of Detroit*
- City of Gates*
- City of Hubbard
- City of Jefferson
- City of Mill City*
- City of St. Paul
- City of Salem (West Salem)*
- City of Scotts Mills
- City of Sublimity
- City of Woodburn
- Community of Four Corners
- Community of Butteville
- Community of Labish Village
- Community of Mehama
- City of Aurora
- City of Donald
- City of Gervais
- City of Idanha
- City of Keizer
- City of Mt. Angel
- City of Salem
- City of Silverton
- City of Stayton
- City of Turner

*Portions of the cities of Detroit, Gates, and Mill City that were within Linn County are included in this report. The City of Salem that was within Polk County was examined individually and designated as City of Salem (West Salem).

Selected countywide results

Total buildings: 170,562

Total estimated building value: $62 billion

Mt. Angel Deterministic Magnitude 6.8 Earthquake Scenario
Red-tagged buildings[a]: 7,479
Yellow-tagged buildings[b]: 17,028
Loss estimate: $6.7 billion

100-year Flood Scenario
Number of buildings damaged: 2,552
Loss estimate: $126 million

Landslide Exposure (High and Very High-Susceptibility)
Number of buildings exposed: 7,470
Exposed building value: $2.7 billion

Channel Migration Zone (Erosion Hazard Area – 30-year):
Number of buildings exposed: 826
Exposed building value: $300 million

Wildfire Exposure (High and Moderate Risk):
Number of buildings exposed: 2,819
Exposed building value: $814 million

Lahar Exposure (1,000 to 15,000-year):
Number of buildings exposed: 1,789
Exposed building value: $415 million

[a]Red-tagged buildings are considered uninhabitable due to complete damage
[b]Yellow-tagged buildings are considered limited habitability due to extensive damage

1.0 INTRODUCTION

Key Terms:

- *Vulnerability:* Characteristics that make people or assets more susceptible to a natural hazard.
- *Risk:* Probability multiplied by consequence; the degree of probability that a loss or injury may occur as a result of a natural hazard.

A natural hazard is an environmental phenomenon that can negatively impact humans, and risk is the likelihood that a hazard will result in harm. A natural hazard risk assessment analyzes and quantifies how different types of hazards could affect the built environment, population, and the cost of recovery, and identifies potential risk. Risk assessments are one basis for developing mitigation plans, strategies, and actions, so that steps can be taken to prepare for a potential hazard event.

Although previous multi-hazard risk studies have been completed (Burns and others, 2008), this is the first multi-hazard risk assessment analyzing individual buildings and the resident population in Marion County. It is therefore the most detailed and comprehensive analysis to date of natural hazard risk and provides a comparative perspective never before available. In this report, we describe our assessment results, which quantify the various levels of risk that each hazard presents to Marion County communities.

Marion County is situated in the northwestern part of Oregon in the Willamette Valley and is subject to natural hazards, including: earthquake, riverine flooding, landslides, channel migration, wildfire, and lahar. This region of the state is moderately to heavily developed, composed of dense urban areas transitioning to suburban development in unincorporated parts of the study. There are also large uninhabited areas where the county jurisdiction extents into the Cascade Mountains within national forestland. Where natural hazards have the potential to damage assets or harm people, the result is natural hazard risk. The primary goal of the risk assessment is to inform communities of the risk posed by various natural hazards and to be a resource for risk reduction actions.

1.1 Purpose

The purpose of this project is to help communities in the study area better understand their risk and increase resilience to earthquakes (including liquefaction and site amplification), riverine flooding, landslides, channel migration, and wildfire natural hazards that are present in their communities. This is accomplished by 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 and/or create a database of critical facilities, tax assessor data, buildings, and population distribution data,
- incorporate and use existing data from previous geologic, hydrologic, and wildfire hazard studies,
- perform exposure and Hazus–based risk analysis, and
- share this report 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-MH and exposure), depending on the type of hazard, were used to assess risk. Results for each hazard type are reported on a countywide basis within each hazard section, and community based results are reported in detail in **Appendix A: Community Risk Profiles**. **Appendix B** contains detailed risk assessment tables. **Appendix C** is a more detailed explanation of the Hazus-MH methodology. **Appendix D** lists acronyms and definitions of terms used in this report. **Appendix E** contains tabloid-size maps showing countywide hazard maps.

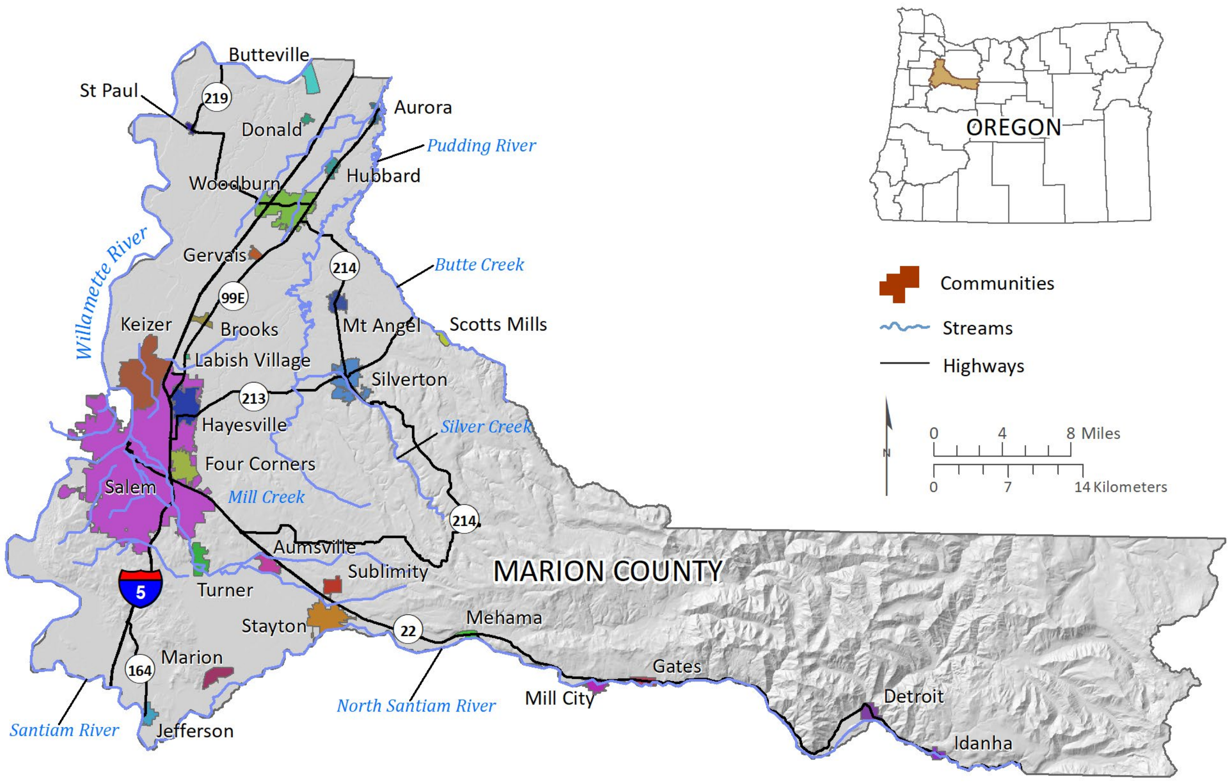
1.2 Study Area

The study area for this project includes the entirety of Marion County, Oregon. To make the report more functional, the study extent was expanded to include portions of the cities of Salem, Mill City, Gates, and Idanha that extend into neighboring counties (**Figure 1-1**). The study area is located in the northwestern portion of the state; the county is bordered by Clackamas County to the north, Wasco County and Jefferson County to the east, Linn County to the south, and Yamhill County and Polk County to the west. The entire western boundary of Marion County with Polk County and Yamhill County is defined by the Willamette River. The total area of Marion County is 3,070 square kilometers (1,184 square miles). Starting in the east, the study area transitions from timberland, to farmland, to suburbs, and then to urban development in the west.

The geography of the county's eastern half consists of the heavily forested Cascade Range. Mount Jefferson, a stratovolcano in the Cascade Range, is located at the southeastern corner of Marion County. The Willamette National Forest makes up a significant portion of the county's eastern half. The western half of the county transitions from the heavily forested mountains to gently rolling farmland and then onto the broad flat bottom of the Willamette Valley.

The population of the study area is approximately 349,000 based on an estimated population for each community in 2020 from the Portland State University (PSU) Population Research Center https://www.pdx.edu/population-research/population-estimate-reports. The study area includes the city of Salem, which is the state capital and the second-largest city in Oregon with a population of approximately 175,000. Most of the residents in the study area live in the western half of the county. The incorporated communities of the study area are Aumsville, Aurora, Detroit, Donald, Gates, Gervais, Hubbard, Idanha, Jefferson, Keizer, Mill City, Mt. Angel, St. Paul, Salem, Scotts Mills, Silverton, Stayton, Sublimity, Turner, and Woodburn (**Figure 1-1**). The portion of Salem that is within Polk County is included in this study and is designated as Salem (West Salem). Portions of the incorporated communities of Detroit, Gates, and Mill City that are within Linn County are included in this study. The unincorporated communities that were individually examined in this study were Brooks, Butteville, Four Corners, Hayesville, Labish Village, Marion, and Mehama.

Figure 1-1. Study area: Marion County with communities in this study identified.



1.3 Project Scope

For this risk assessment, we limited the project scope to buildings and population because of data availability, the strengths and limitations of the risk assessment methodology, and funding availability. We did not analyze impacts to the local economy, land values, infrastructure (transportation, power, water, gas, communication, and sewage), or the environment. Depending on the natural hazard, we used one of two methodologies: loss estimation or exposure. Loss estimation was modeled using methodology from Hazus®-MH (FEMA, 2012a, 2012b, 2012c), a tool developed by FEMA for calculating damage to buildings from flood and earthquake. Exposure is a simpler methodology, in which buildings are categorized based on their location relative to various hazard zones. To account for impacts on population (permanent residents only), 2010 U.S. Census data (U.S. Census Bureau, 2010a) was used to distribute people into residential structures on a census block basis. Permanent resident counts were then adjusted to current estimates from the PSU Population Research Center.

A critical component of this risk assessment is a countywide building inventory developed from building footprint data and the Marion County tax assessor database (acquired 2021). The other key component is a suite of datasets that represent the currently 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 datasets; most datasets are DOGAMI publications. In addition to geologic hazards, we included wildfire hazard in this risk assessment. The following is a list of the risk assessment methodologies that were applied. See **Table 1-1** for data sources.

Earthquake Risk Assessment

- Hazus-MH loss estimation from a Mount Angel Fault magnitude (Mw) 6.8 scenario. Includes earthquake-induced or "coseismic" liquefaction, soil amplification class, and landslides.

Flood Risk Assessment

- Hazus-MH 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 Index and landslide deposit mapping (Low to Very High)

Wildfire Risk Assessment

- Exposure based on Overall Wildfire Risk (Low to High)

Channel Migration Risk Assessment

- Exposure based on the erosion hazard area—30-year (exposed, not exposed)

Volcanic Lahar Risk Assessment

- Exposure to three potential lahar scenarios (Small to Large)

Table 1-1. Hazard data sources for Marion County.

Hazard	Scenario or Classes	Scale/Level of Detail	Data Source
Earthquake	Mount Angel deterministic Mw-6.8	Countywide	FEMA (Hazus-MH 5.0 fault database)
- Coseismic landslide	Susceptibility – wet (3-10 hazard classes)	Statewide	DOGAMI (Madin and others, 2021)
- Coseismic liquefaction	Susceptibility (1-5 classes)	"	"
- Coseismic Soil amplification	NEHRP (A-F classes)	"	"
Flood	Depth Grids: 10% (10-yr) 2% (50-yr) 1% (100-yr) 0.2% (500-yr)	Countywide	DOGAMI (Appleby and others, 2021) – derived from FEMA (2019) data
Landslide	Susceptibility (Low, Moderate, High, Very High)	Statewide, Countywide	DOGAMI (Burns and others, 2016), DOGAMI (Calhoun and others, 2020)
Channel Migration	Susceptibility (Not Exposed, Exposed)	Pudding and 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 surrounding areas	USGS (Walder and others, 1999)

1.4 Previous Studies

Wang (1998) used Hazus-MH to estimate the impact from a Mw-8.5 Cascadia Subduction Zone (CSZ) earthquake scenario on the state of Oregon. The results of that study were arranged into individual counties. Marion County was estimated to experience a 3.5% loss ratio in the Mw-8.5 CSZ scenario (Wang, 1998).

Burns and others (2008) developed earthquake and landslide hazard maps and used Hazus-MH to estimate future earthquake damage for the Mid/Southern Willamette Valley which included Marion County. The earthquake scenarios used in the Hazus-MH analysis were the Mt. Angel Fault, magnitude (Mw) 6.9 and the CSZ, Mw-9.0. Both scenarios aggregated results at the census tract level using the default Hazus-MH general building stock database. Estimated loss ratios for Marion County were 43% for the Mt. Angel Fault and 25% for the CSZ scenarios.

We did not compare the results of this projects with the results of these previous studies because the level of detail and accuracy of the building information and site-specific earthquake inputs were not comparable. Comparative analysis was not part of the scope of this project.

2.0 METHODS

Where there is interaction between people and natural hazards there is risk. We used a quantitative approach through two modes of analysis, Hazus-MH loss estimation and exposure, to assess the level of risk to buildings and people from natural hazards.

2.1 Hazus-MH Loss Estimation

According to FEMA (FEMA, 2012a, p. 1-1), "Hazus provides nationally applicable, standardized methodologies for estimating potential wind, flood, and earthquake losses on a regional basis. Hazus can be used to conduct loss estimation for floods and earthquakes […]. The multi-hazard Hazus is intended for use by local, state, and regional officials and consultants to assist mitigation planning and emergency response and recovery preparedness. For some hazards, Hazus can also be used to prepare real-time estimates of damages during or following a disaster."

Key Terms:

- *Loss estimation:* Damage in terms of value that occurs to a building in an earthquake or flood scenario, as modeled with Hazus-MH 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.

Hazus-MH 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. Cost 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-MH database.

Damage functions are at the core of Hazus-MH. The damage functions stored within the Hazus-MH 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 Hazus-MH flood analysis by showing the percentage of building loss from flood and in some cases (in yellow) where a building's first floor height is above the level of flooding.

We used Hazus-MH version 5.0 (FEMA, 2021), which was the latest version available when we began this risk assessment.

Figure 2-1. 100-year flood zone and building loss estimates example in city of Salem, Oregon.

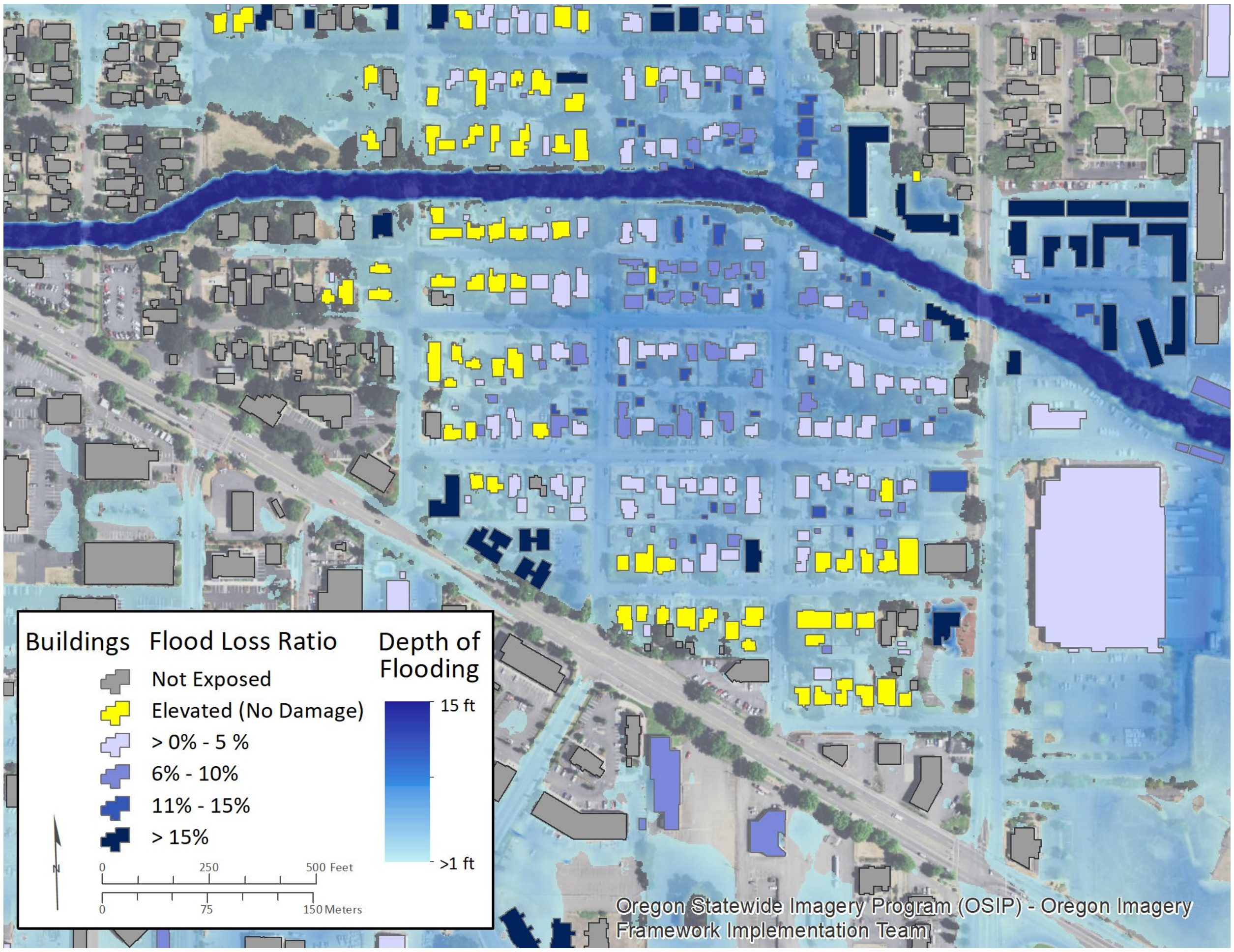


Image source: Oregon Statewide Imagery Program, 2018

Depth grid: Derived from the effective FEMA Flood Insurance Rate Map data for Marion County, 2019

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-MH is not available for all types of hazards, we used exposure analysis to assess the level risk for Marion County for landslide, channel migration, wildfire, and lahar hazards. Exposure methodology identifies the buildings and population that are within a particular natural hazard zone. This is an alternative for natural hazards that do not have available damage models like those in Hazus. It provides a way to easily quantify what is and what 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 areas of landslide susceptibility where building footprints are colored based on what susceptibility zone the center of the building is within.

Exposure is used for landslide, wildfire, channel migration, and volcanic lahar. For comparison with loss estimates, exposure is also used for the 1% annual chance flood.

Figure 2-2. Landslide susceptibility areas and building exposure example in the city of Mill City, Oregon.

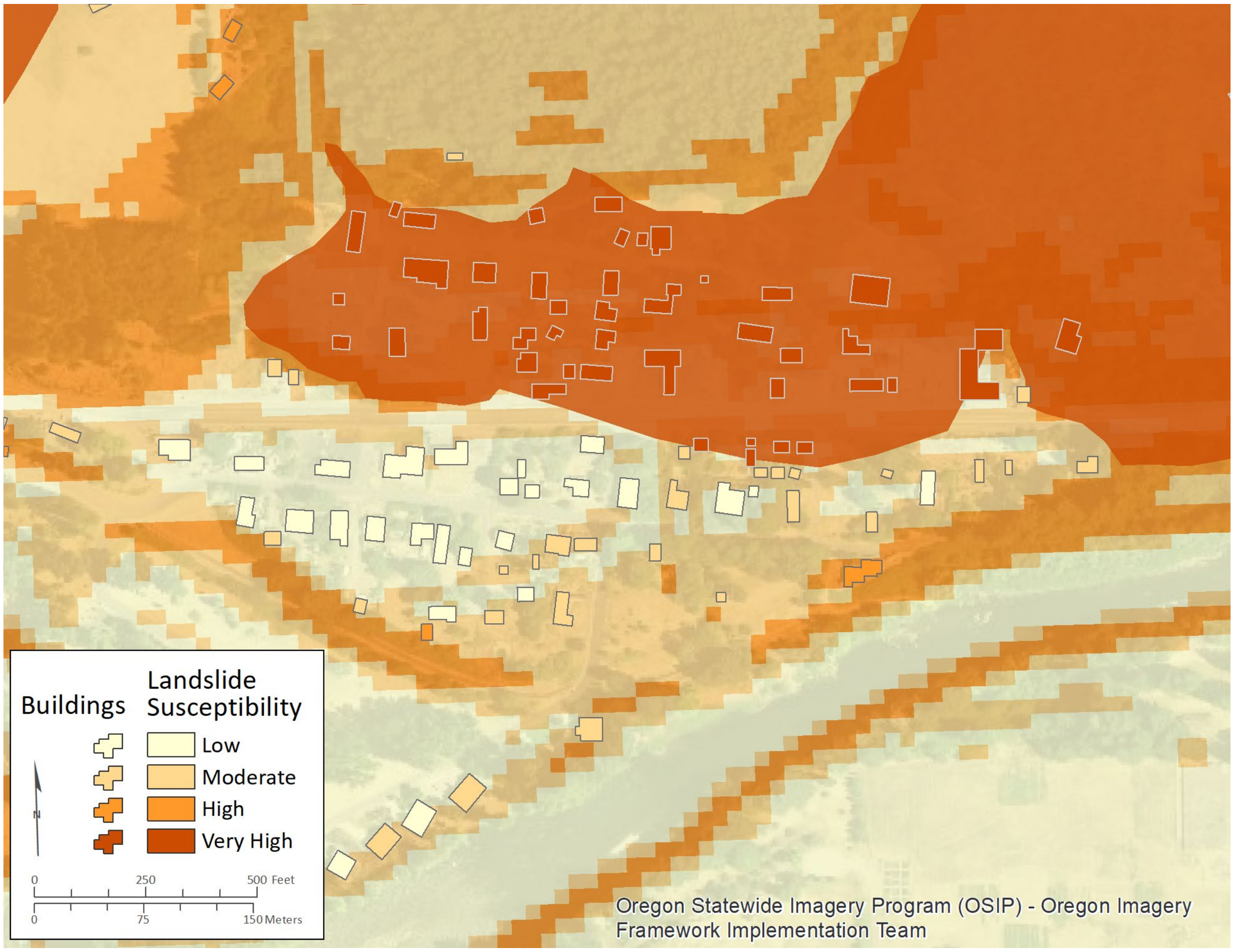


Image source: Oregon Statewide Imagery Program, 2018

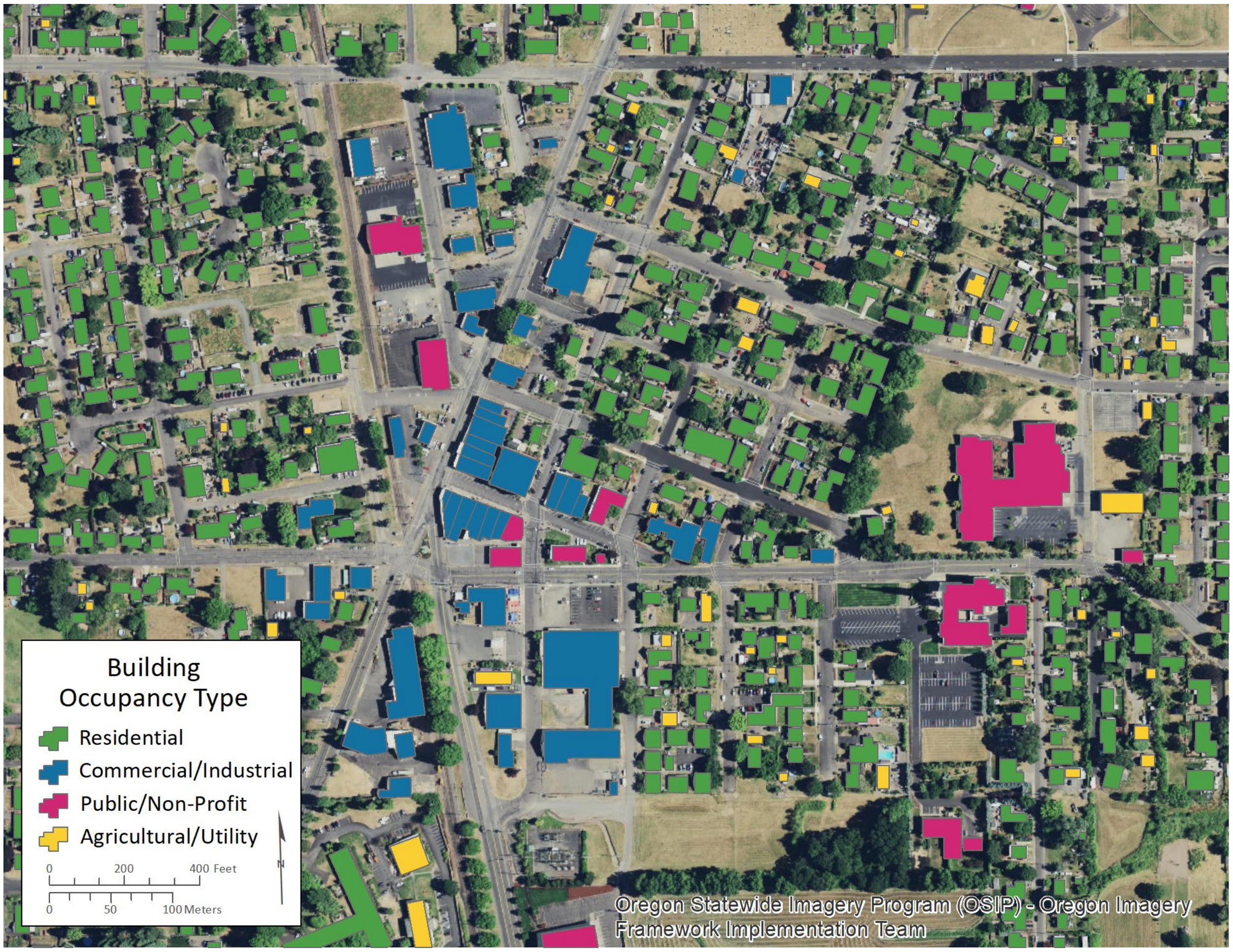
Landslide data source: Landslide susceptibility overview map of Oregon, (Burns and others, 2016)

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 the Hazus-MH and exposure analyses in Marion County. See also **Appendix B: Table B-1** and **Appendix E: Plate 1** and **Plate 2.**

To use the building inventory within the Hazus-MH methodology, we converted the building footprints 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-MH version 2.1 technical manuals (FEMA, 2012a, 2012b, 2012c) 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. Example of building occupancy types, city of Mt. Angel, Oregon.



The distribution of building count and value per community in Marion County ranges from 159 buildings and $35 million for Idanha to 58,163 buildings and $22.5 billion for Salem (**Table 2-1**). A table detailing the occupancy class distribution by community is included in **Appendix B: Detailed Risk Assessment Tables**.

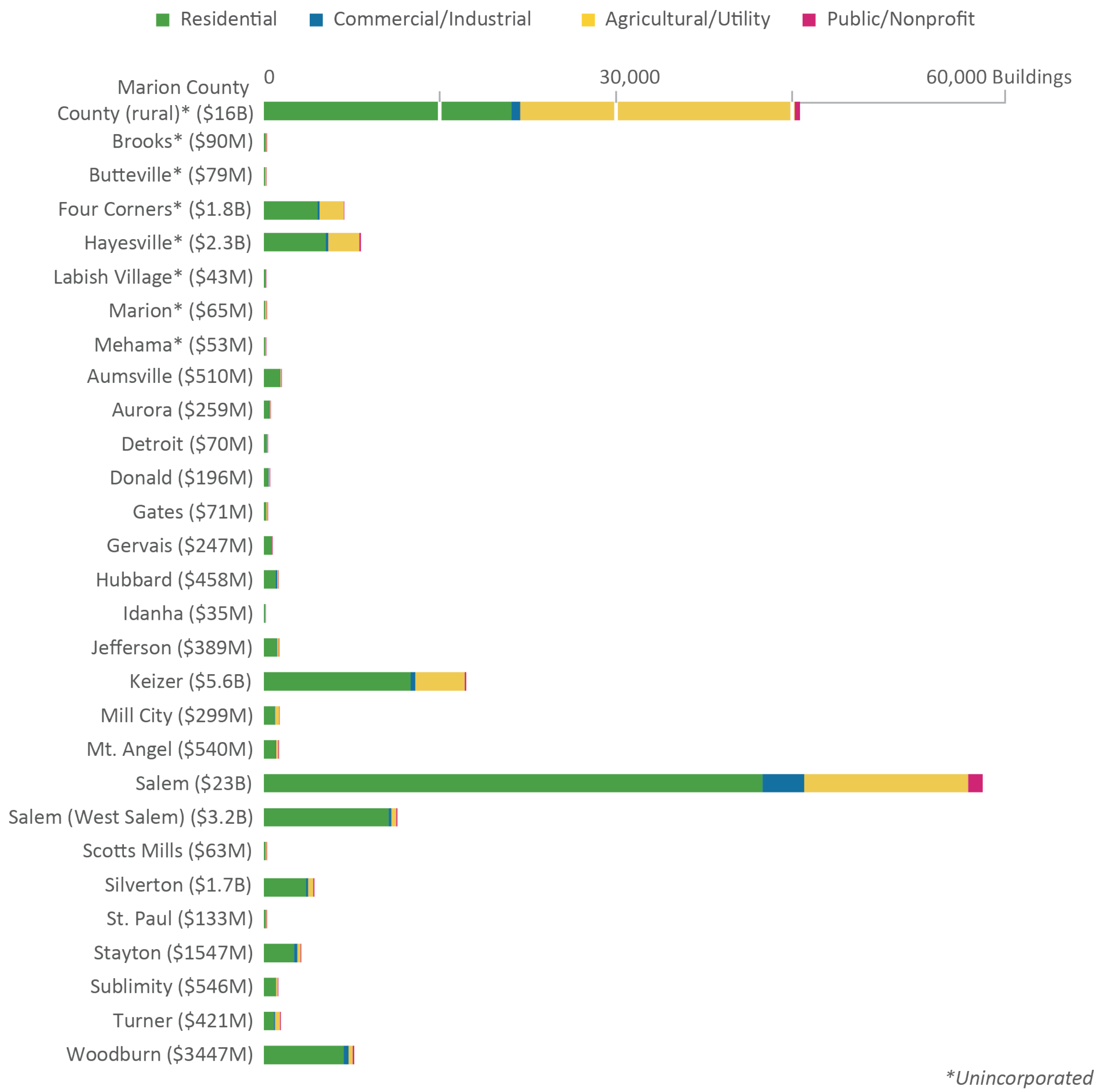
Table 2-1. Marion County building inventory.

Community	Total Number of Buildings	Percentage of Total Buildings	Estimated Total Building Value ($)	Percentage of Total Building Value
Unincorp. Marion Co (rural)	43,387	25.4%	16,042,238,000	26%
Brooks	249	0.1%	89,505,000	0.1%
Butteville	193	0.1%	78,691,000	0.1%
Four Corners	6,508	3.8%	1,801,596,000	2.9%
Hayesville	7,876	4.6%	2,382,452,000	3.8%
Labish Village	167	0.1%	43,407,000	0.1%
Marion	244	0.1%	64,728,000	0.1%
Mehama	189	0.1%	53,460,000	0.1%
Total Unincorporated County	58,813	34.5%	20,556,077,000	33%
Aumsville	1,459	0.9%	509,635,000	0.8%
Aurora	560	0.3%	258,763,000	0.4%
Detroit	315	0.2%	69,925,000	0.1%
Donald	490	0.3%	195,528,000	0.3%
Gates	326	0.2%	71,352,000	0.1%
Gervais	719	0.4%	247,297,000	0.4%
Hubbard	1,187	0.7%	458,199,000	0.7%
Idanha	159	0.1%	35,338,000	0.1%
Jefferson	1,243	0.7%	389,441,000	0.6%
Keizer	16,380	9.6%	5,592,798,000	8.9%
Mill City	1,269	0.7%	299,237,000	0.5%
Mt. Angel	1,219	0.7%	539,815,000	0.9%
Salem	58,163	34.1%	22,532,083,000	36%
Salem (West Salem)	10,797	6.3%	3,194,904,000	5.1%
Scotts Mills	242	0.1%	63,043,000	0.1%
Silverton	4,077	2.4%	1,740,060,000	2.8%
St. Paul	247	0.1%	132,631,000	0.2%
Stayton	3,043	1.8%	1,546,547,000	2.5%
Sublimity	1,157	0.7%	546,449,000	0.9%
Turner	1,365	0.8%	421,185,000	0.7%
Woodburn	7,332	4.3%	3,446,910,000	5.5%
Total Study Area	170,562	100%	62,847,216,000	100%

The building inventory was developed from a building footprints dataset developed in 2021 called the Statewide Building Footprints for Oregon, release 1 (SBFO-1) (Williams, 2021). The SBFO-1 data of Marion County was modified from a building footprints dataset maintained by the city of Salem (obtained June 2020). The building footprints provide a spatial location and 2D representation of a structure. The total number of buildings within the study area was 170,562.

Marion County supplied assessor data and we formatted them for use in the risk assessment. The assessor data contains an array of information about each improvement (i.e., building). Tax lot data, which contains property boundaries and other information regarding the property, were obtained from the county assessor and were 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 assessments for both loss estimation and exposure analysis. The majority of buildings are within the jurisdictions of the unincorporated county, Salem, and Keizer, and the most common building usage in the study area is residential (**Figure 2-4**).

Figure 2-4. Community building value in Marion County by occupancy class.



Critical facilities are important to note because these facilities play a crucial role in emergency response efforts. 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 by reviewing Google Maps™ data. The critical facilities we identified include hospitals, schools, fire stations, police stations, emergency operations, and military facilities. In addition, we included other buildings based on specific community input and structures that would be essential during a natural hazard event, such as public works and water treatment facilities. 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 unincorporated county and Salem (**Table 2-2**). Critical facilities are listed for each community in **Appendix A**.

Table 2-2. Marion County critical facilities inventory.

	Hospital & Clinic		School		Police/Fire		Emergency Services		Military		Other*		Total	
Community	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)	Count	Value ($)
	(all dollar amounts in thousands)													
Uninc Marion Co (rural)	0	0	32	222,199	17	26,342	1	3,645	0	0	8	110,070	58	362,256
Brooks	0	0	2	10,380	0	0	0	0	0	0	0	0	2	10,380
Butteville	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Four Corners	0	0	3	37,353	0	0	0	0	0	0	0	0	3	37,353
Hayesville	0	0	6	60,750	1	2,994	0	0	0	0	0	0	7	63,744
Labish Village	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marion	0	0	0	0	1	306	0	0	0	0	0	0	1	306
Mehama	0	0	0	0	1	791	0	0	0	0	0	0	1	791
Total Uninc. County	0	0	43	330,682	20	30,433	1	3,645	0	0	8	110,070	72	474,830
Aumsville	0	0	2	38,868	2	4,462	0	0	0	0	1	1,071	5	44,401
Aurora	0	0	0	0	2	2,918	0	0	0	0	0	0	2	2,918
Detroit	0	0	0	0	1	473	0	0	0	0	0	0	1	473
Donald	0	0	0	0	1	1,430	0	0	0	0	0	0	1	1,430
Gates	0	0	0	0	1	1,227	0	0	0	0	0	0	1	1,227
Gervais	0	0	2	43,279	0	0	0	0	0	0	1	1,697	3	44,976
Hubbard	0	0	0	0	2	3,754	0	0	0	0	1	336	3	4,090
Idanha	0	0	0	0	1	760	0	0	0	0	0	0	1	760
Jefferson	0	0	1	11,888	1	1,657	0	0	0	0	0	0	2	13,545
Keizer	1	4,557	12	163,943	3	25,017	0	0	0	0	0	0	16	193,517
Mill City	0	0	2	24,319	1	2,319	0	0	0	0	0	0	3	26,638
Mt. Angel	1	891	3	37,489	2	3,671	0	0	0	0	1	837	7	42,888
Salem	7	148,614	53	750,052	10	47,524	1	19,038	4	33,228	5	236,483	80	1,234,939
Salem (West Salem)	1	2,578	9	145,936	2	2,694	0	0	0	0	0	0	12	151,208
Scotts Mills	0	0	1	5,687	1	1,742	0	0	0	0	0	0	2	7,429
Silverton	5	32,651	5	100,286	2	6,532	0	0	0	0	1	1,654	13	141,123
St. Paul	0	0	3	23,762	1	3,095	0	0	0	0	0	0	4	26,857
Stayton	1	16,142	6	93,544	2	9,115	1	2,238	0	0	2	4,840	12	125,879
Sublimity	0	0	2	9,733	1	2,557	0	0	0	0	1	717	4	13,007
Turner	0	0	1	7,729	2	4,980	0	0	0	0	0	0	3	12,709
Woodburn	5	32,796	10	153,206	3	16,683	0	0	0	0	1	1,452	19	204,137
Total Study Area	21	238,229	155	1,940,403	61	173,043	3	24,921	4	33,228	22	359,157	266	2,768,981

Note: Facilities with multiple buildings were consolidated into one building.

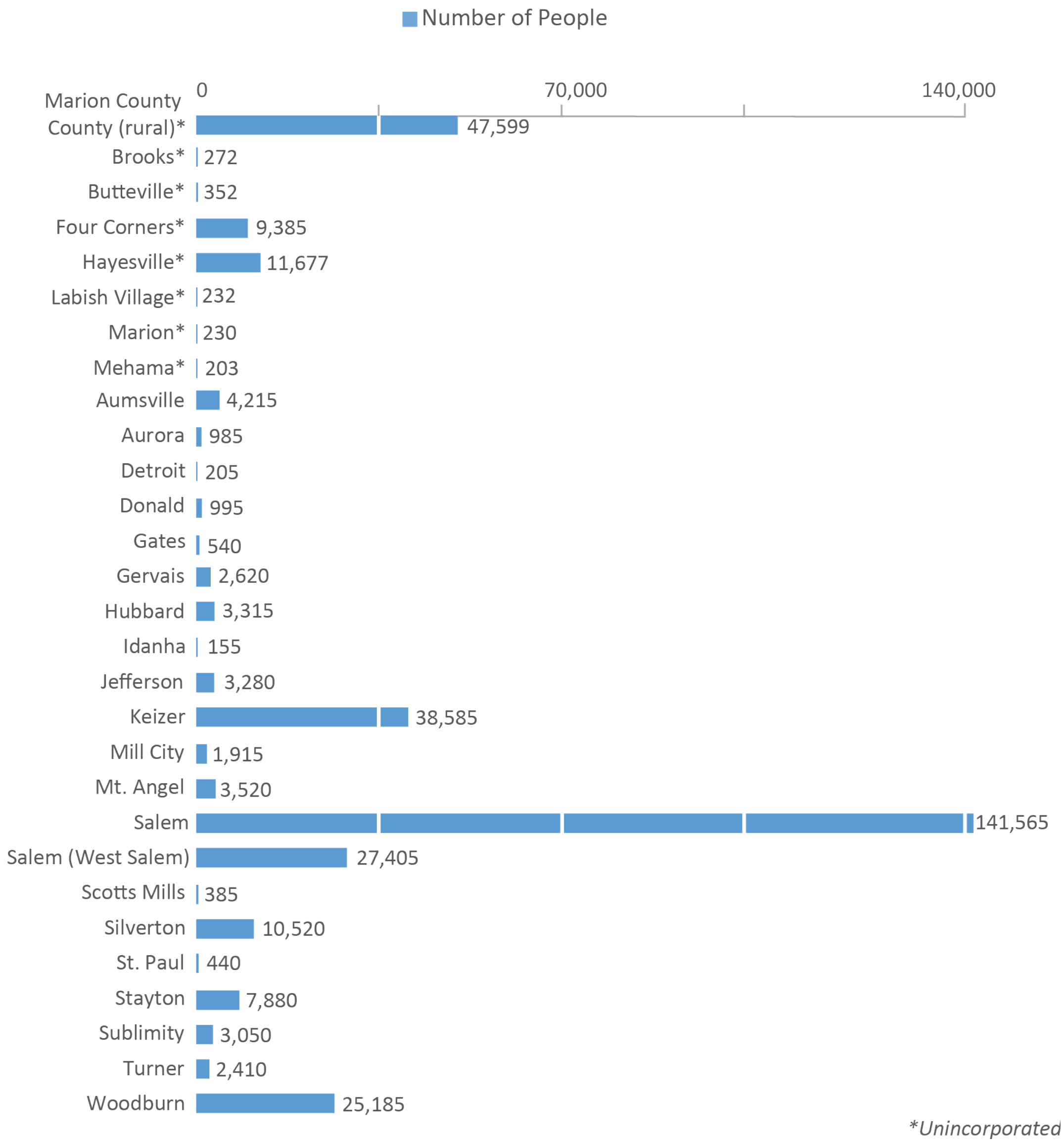
* Category includes buildings that are not traditional (emergency response) critical facilities but considered critical during an emergency based on input from local stakeholders (e.g., water treatment facilities or airports).

2.4 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 population of permanent residents reported per census block was distributed among residential buildings and pro-rated based on building area derived from 2010 U.S. Census data. This census block-based distribution was further adjusted with the PSU Population Research Center estimates for 2021 (**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, the distribution includes vacation homes, which in many communities make up a small portion of the residential building stock. From information reported in the 2010 U.S. Census regarding vacation rentals within the county, it is estimated that approximately 4% of residential buildings are vacation rentals in Marion County (U.S. Census Bureau, 2010b).

From the Census and PSU Population Research Center data, we assessed the risk of the 349,120 residents within the study area that could be affected by a natural hazard scenario. For each natural hazard, with the exception of the earthquake scenario, a simple exposure analysis was used to find the number of potentially displaced residents within a hazard zone. For the earthquake scenario 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 Marion County community.



3.0 ASSESSMENT OVERVIEW AND RESULTS

In these risk assessments, we considered six natural hazards (earthquake, flood, landslide, wildfire, channel migration, and volcanic lahar) that pose a risk to Marion County. The assessment describes both localized vulnerabilities and the widespread challenges that impact all communities. While results of this risk assessment do not typically represent singular hazard events, they do quantify the potential overall level of risk present for assets and residents. The loss estimation and exposure results, as well as the rich dataset included with this report, can lead to greater understanding of the potential impact of 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 all unincorporated areas and cities within Marion County. Individual community results are in **Appendix A: Community Risk Profiles.**

3.1 Earthquake

An earthquake is a sudden movement of rock on each side of a fault in the earth's crust, which abruptly releases strain that has accumulated. The movement along the fault produces waves of shaking that spread in all directions. If an earthquake occurs near populated areas, it may cause causalities, economic disruption, and extensive property damage (Madin and Burns, 2013).

Two earthquake-induced hazards, also called coseismic 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. Coseismic landslides are mass movement of rock, debris, or soil induced by ground shaking. All earthquake damages in this report include damages derived from shaking and from liquefaction and landslide factors.

3.1.1 Data sources

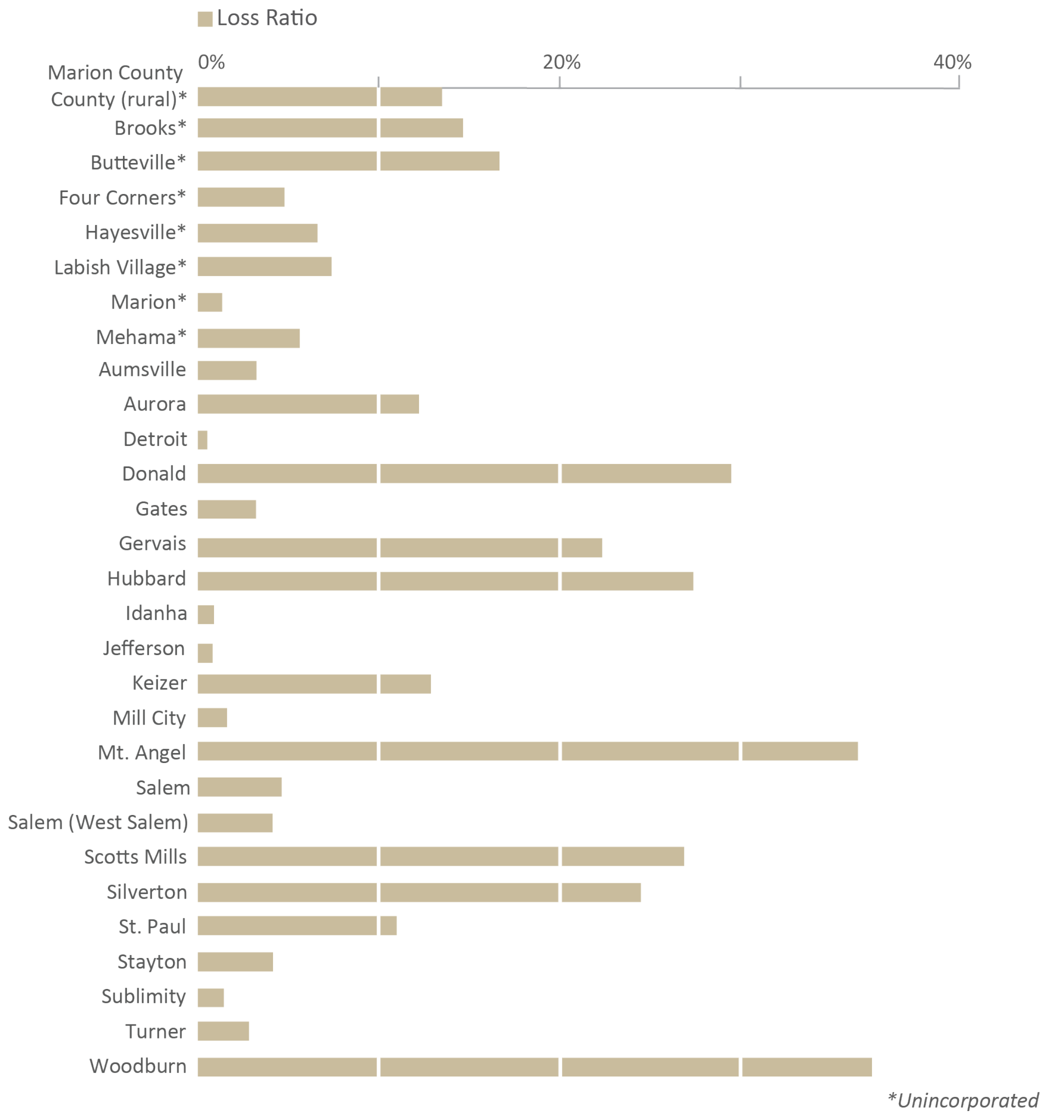
Hazus-MH offers two scenario methods for estimating loss from earthquake: probabilistic and deterministic (FEMA Hazus-MH, 2012b). A probabilistic scenario uses U.S. Geological Survey (USGS) National Seismic Hazard Maps, which are derived from seismic hazard curves calculated on a grid of sites across 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, such as a CSZ Mw-9.0 event. We used the deterministic scenario method for this study along with the UDF database so that loss estimates could be calculated on a building-by-building basis.

The Mt. Angel Fault is an active fault located near the cities of Mt. Angel, Woodburn, and Silverton. On March 25, 1993, a Mw-5.7 earthquake occurred with an epicenter approximately 5 kilometers (about 3 miles) east of the city of Scotts Mills, Oregon. Many buildings were damaged from the event, including the Capitol building in Salem. Many unreinforced masonry buildings in the area were significantly damaged due to intense shaking. The preliminary damage estimate was $28.4 million ($50 million in 2022) (Black, 1996).

The Mt. Angel Fault deterministic scenario was selected as the most appropriate for communicating earthquake risk for Marion County. We based this decision on several factors, such as previous Hazus-MH earthquake analyses in the region, location of the active fault relative to nearby structures, local familiarity from the 1993 event, and available seismic data. The default Hazus-MH database contained the location and orientation of the fault and provided a recommended magnitude for use in a simulated earthquake event.

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, landslide susceptibility (wet), and liquefaction susceptibility. The liquefaction and landslide susceptibility layers were used by the Hazus-MH tool to calculate the probability and magnitude of permanent ground deformation caused by these factors. Hazus-MH uses a characteristic magnitude value to calculate the impacts of liquefaction and landslides. For this study, we followed the details provided in the default Hazus-MH database and used Mw-6.8 as the characteristic event.

Figure 3-1. Mt. Angel Fault Mw-6.8 earthquake loss ratio by Marion County community.



3.1.2 Countywide results

Because an earthquake can affect a wide area, it is unlike other hazards in this report—every building in Marion County, to some degree, will be shaken by a Mt. Angel Fault Mw-6.8 earthquake. Hazus-MH loss estimates (**Table B-2)** for each building are based on a formula where coefficients are multiplied by each of the five damage state percentages (none, low, moderate, extensive, and complete). These damage states are correlated to loss ratios that are then multiplied by the building dollar value to obtain a loss estimate (FEMA, 2012b). Loss estimates from the earthquake scenario described in this report vary widely by community in Marion County (**Figure 3-1**).

In keeping with earthquake damage reporting conventions, we used the 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. 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, 2012b).

We considered critical facilities nonfunctioning 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, 2012b). Because building specific information is more readily available for critical facilities and due to their importance after a disaster, we chose to report the results of these buildings individually.

The probability of damage state was determined by Hazus-MH earthquake analysis, and we reviewed the damage states in the results. The number of potentially displaced residents from an earthquake scenario described in this report was based on the formula: ([Number of Occupants] * [Probability of Complete Damage]) + (0.9 * [Number of Occupants] * [Probability of Extensive Damage]) (FEMA, 2012b). The probability of damage state was determined in the Hazus-MH earthquake analysis results.

Marion countywide Mt. Angel Fault Mw-6.8 earthquake results:

- Number of red-tagged buildings: 7,479
- Number of yellow-tagged buildings: 17,028
- Loss estimate: $6,671,977,000
- Loss ratio: 11%
- Non-functioning critical facilities: 85
- Potentially displaced population: 15,064

The results indicate that Marion County could incur moderate to significant losses (11%) due to a Mt. Angel Fault Mw-6.8 earthquake. These results are strongly influenced by proximity to the Mt. Angel Fault and ground deformation from liquefaction. The communities in the northeast part of the county (Gervais, Hubbard, Mt. Angel, Scotts Mills, Silverton, and Woodburn), close to the Mount Angel Fault, all have higher levels of estimated losses compared with the rest of the county. This is consistent with the damage that occurred from the 1993 Scotts Mills earthquake. In addition, high liquefaction susceptibility exists within most of the floodplains throughout the county which increases the risk from earthquakes. A large portion of Keizer and developed areas along the North Santiam River are built on highly liquefiable soils have higher estimates of damage from this earthquake scenario than other communities in the study area.

Although the impacts of coseismic landslides were included in the Hazus earthquake results, we did not perform an analysis that specifically isolated damage caused by coseismic landslides. It is worth noting that coseismic landslides likely contribute a small percentage of the overall estimated damage from the earthquake hazard in Marion County. Landslide exposure results show that 4.3% of buildings in Marion County are within a Very High or High susceptibility zone. This indicates that a similar percentage of the loss estimated in this study may be due to coseismic landslide.

Building vulnerabilities such as the age of the building stock and building type are also contributing factors in damage 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 66% of Marion County's buildings were built before the 1990s. Certain building types are known to be more vulnerable than others in earthquakes, such as manufactured homes. In Hazus-MH, 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 buildings could be seismically retrofitted to Moderate or High code standards, earthquake risk would be greatly reduced. In this study, a simulation in Hazus-MH earthquake analysis shows that loss ratios drop from 11% to 7%, when all buildings are upgraded to at least Moderate code level. While retrofits can decrease earthquake vulnerability, for areas of High landslide or liquefaction hazard, additional geotechnical mitigation may be necessary to have an effect on losses. Two simulations of a deterministic Mw-6.8 earthquake where all buildings are upgraded to Moderate code standards or to High code standards show a reduction in loss estimates (**Figure 3-2**).

Key Terms:

- *Seismic retrofit:* Structural modification to a building that improves its resilience to earthquake.
- *Design level:* Hazus-MH 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.

As a means of comparison, we also ran a CSZ Mw-9.0 scenario in Hazus for the same building dataset. While the overall damages and number of potentially displaced population are fewer than the Mt. Angel scenario, the damage is more widespread throughout the county. Emergency response could be more difficult in this scenario because emergency services would not be concentrated in a specific area of the county. In addition to a thinned-out response within the county itself, the regional impact may further exacerbate the level of demand for these services.

Marion countywide CSZ Mw-9.0 earthquake results:

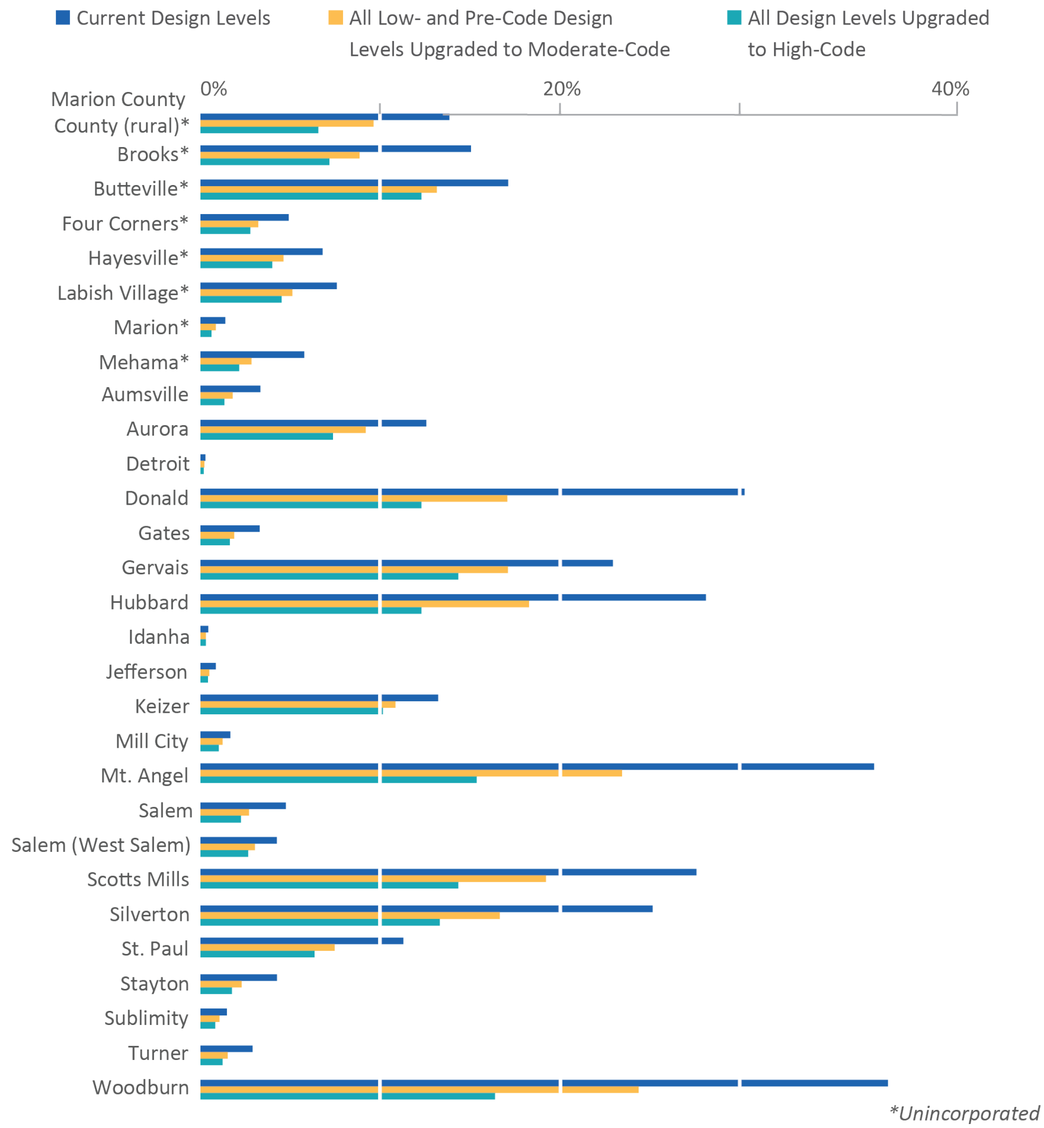
- Number of red-tagged buildings: 4,040
- Number of yellow-tagged buildings: 9,294
- Loss estimate: $2,820,655,000
- Loss ratio: 4.5%
- Non-functioning critical facilities: 44
- Potentially displaced population: 8,086

3.1.3 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk to earthquake hazard:

- Areas near the epicenter of the simulated earthquake scenario are likely to incur a significant amount of damage. The communities of Mt. Angel, Scotts Mills, Silverton, and Woodburn have higher estimated loss ratios compared to other communities in the study due to the level of shaking likely to occur.
- Buildings along the Willamette, the Santiam, and North Santiam Rivers are at higher risk from earthquake damage due to significant exposure to liquefaction.
- Unreinforced masonry buildings in the older downtown portions of Salem, Silverton, and Stayton are more vulnerable to substantial damage during an earthquake compared to other nearby structures built to modern standards. The Molalla Union High School, an unreinforced masonry building, was significantly damaged during the 1993 Scotts Mills earthquake (Dewey and others, 1994).
- 82 of the 236 critical facilities in the study area are estimated to be nonfunctioning due to an earthquake similar to the one simulated in this study.

Figure 3-2. Mt. Angel deterministic Mw-6.8 earthquake loss ratio in Marion County, with simulated seismic building code upgrades.



3.2 Flooding

The frequency and severity of flooding 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 flood hazards and flood risk, but we recognize that flood models and risk assessments will need to be updated with time and changing conditions.

In its most basic form, a flood is an accumulation of water over normally dry areas. 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 Marion 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. Flood issues such as flash flooding, ice jams, post-wildfire floods, and dam safety were not examined in this report.

A typical method for determining flood risk is to identify the probability and impact of flooding. 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, and the level of accuracy of that assessment is influenced by modeling methodology advancements, better knowledge, and longer periods of record for the stream or water body in question.

The major rivers and creeks within the county are the Mill Creek (near Salem), the Mill Creek (near Woodburn), Butte Creek and Silver Creek, and the Pudding, North Santiam, Santiam, and Willamette Rivers. In addition, there are several tributaries to these major streams that have mapped flood zones. All the mapped streams are subject to flooding and damaging buildings within the floodplain.

The impacts of flooding are determined by adverse effects to human activities within the natural and built environment. Through strategies such as flood hazard mitigation these adverse impacts can be reduced. Examples of common mitigating activities are elevating structures above the expected level of flooding or removing the structure through FEMA's property acquisition ("buyout") program.

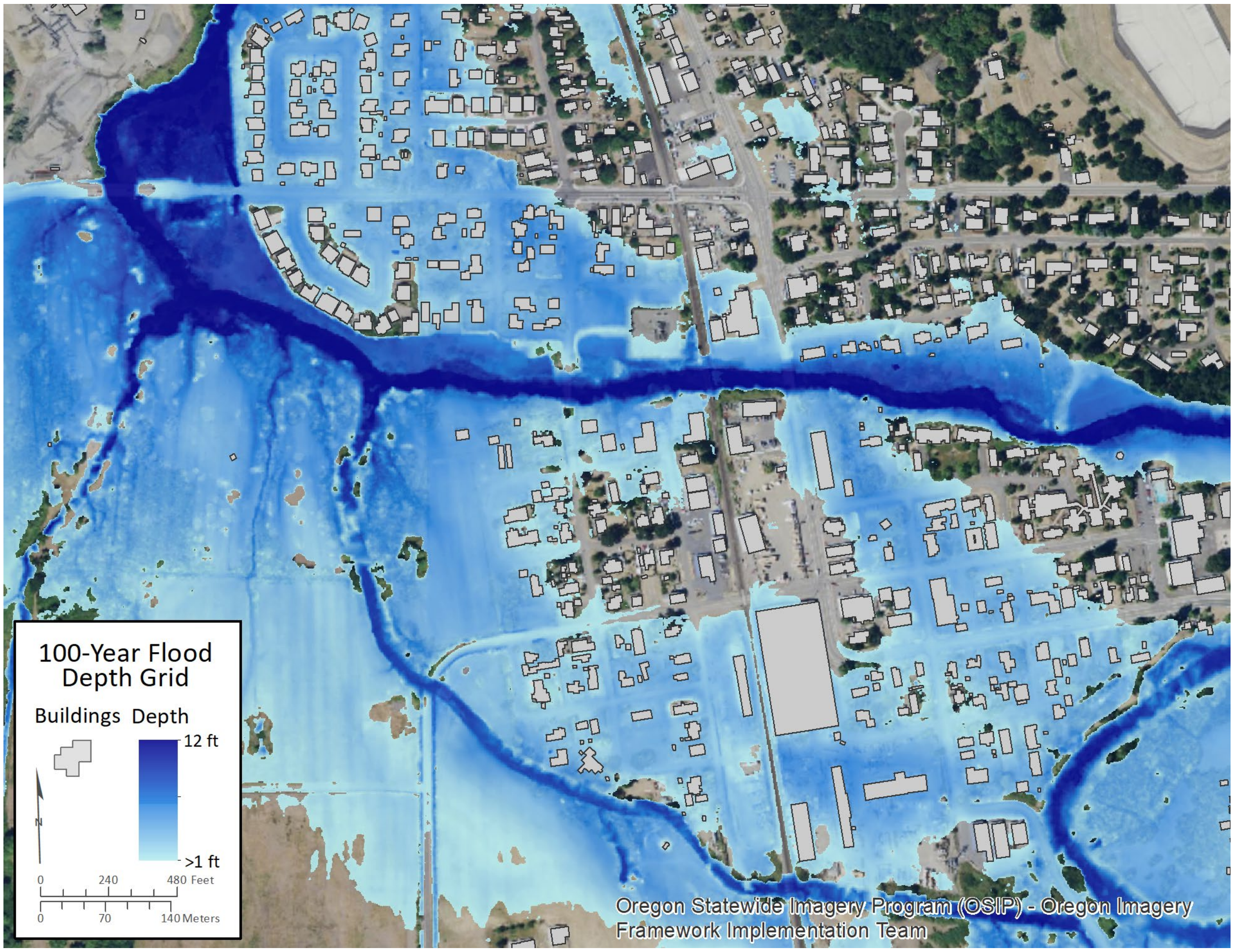
3.2.1 Data sources

The Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for the study area were updated and made effective in 2019 (FEMA, 2019); these were the primary data sources for the flood risk assessment. Further information regarding NFIP related statistics can be found at FEMA's website: https://www.fema.gov/policy-claim-statistics-flood-insurance. These were the only flood data sources that we used in the analysis, but flooding does occur in areas outside of the detailed mapped areas.

DOGAMI developed the 10-, 50-, 100-, and 500-year depth grids from detailed stream model information within the study area (Appleby and Williams, 2021). DOGAMI used high-resolution lidar collected in 2009, 2013, and 2018 to create the depth grids (Willamette Valley 2009 project, Clackamol 2013 project, and Santiam 2018 project - Oregon Lidar Consortium; see http://www.oregongeology.org/lidar/collectinglidar.htm). 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 GIS datasets in which each digital pixel value represents the depth of flooding at that location within the flood zone **(Figure 3-3)**. Depth grids for four riverine flooding scenarios (10-, 50-, 100-, and 500-year) were used for loss estimations and, for comparative purposes, exposure analysis.

Figure 3-3. Flood depth grid example in the city of Turner, Oregon.



Building loss estimates are determined in 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 Marion 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 oblique imagery and street-level imagery to estimate these important building attributes. Only buildings in a flood zone or within 152 meters (500 feet) of a flood zone were examined closely to attribute buildings with more accurate information for first-floor height and basement presence. 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-MH and ran a flood analysis for four flood scenarios (10-, 50-, 100-, and 500-year). We used the 100-year flood scenario as the primary scenario for reporting flood results (also see **Appendix E, Plate 4**). 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.

Marion countywide 100-year flood loss:

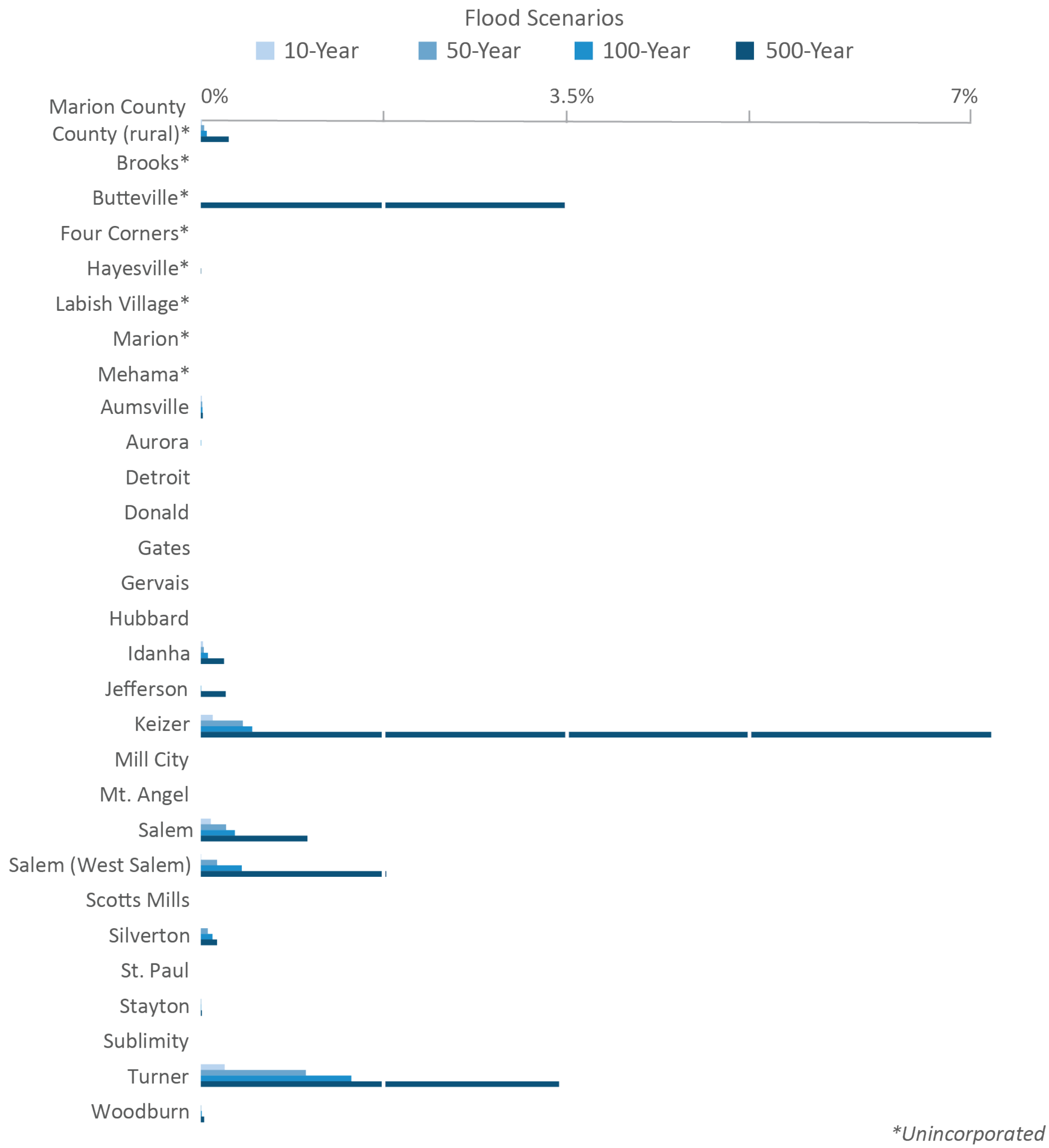
- Number of buildings damaged: 2,552
- Loss estimate: $126,324,000
- Loss ratio: 0.2%
- Damaged critical facilities: 10
- Potentially displaced population: 4,568

3.2.3 Hazus-MH analysis

The Hazus-MH loss estimate for the 100-year flood scenario for the entire county is more than $126 million. While the loss ratio of flood damage for the entirety of Marion County is 0.2%, the impact to areas of development near flood-prone streams is significant (**Figure 3-4**). In situations with 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 flood data on individual communities so that planners can identify problems and consider which mitigating activities will provide the greatest resilience to flooding.

The main flooding problems within Marion County are primarily in the areas of Turner and Salem near the Mill Creek floodplain. The community of Keizer also has a high level of estimated damage from the Willamette River and its tributaries that flow through the community. (**Figure 3-4**). 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.

Figure 3-4. Ratio of flood loss estimates by Marion County community.



3.2.4 Exposure analysis

Separate from the Hazus-MH flood analysis, we did an exposure analysis by overlaying building locations on the 100-year flood extent. We 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 non-damaged buildings from Hazus-MH with the number of exposed buildings in the flood zone. A small proportion (2%) of Marion County's buildings were found to be within designated flood zones. Of the 3,053 buildings that are exposed to flooding, we estimate that 501 are above the height of the 100-year flood. This evaluation also estimates that 4,568 residents might have mobility or access issues due to surrounding water. See **Appendix B: Table B-5** for community-based results of flood exposure.

3.2.5 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk from flood hazard:

- The very large floodplain of Mill Creek (near Salem) and its tributaries from the city of Turner to Salem correspond to high levels of urban development. This area is at high risk from flood hazard.
- Many buildings in the city of Keizer along Labish Ditch are at risk of the estimated 500-year flood.
- Buildings within the Willamette River floodplain, particularly in the city of Salem, including West Salem, are at risk from flood hazard.

3.3 Landslide Susceptibility

This study represents our current understanding of landslide susceptibility within this study area. However, changing climate, precipitation patterns, land use, wildfire events, and land and forest management strategies may increase or decrease the susceptibility to landslides.

Landslides are mass movements of rock, debris, or soil most commonly downhill. There are many different types of landslides in Oregon. In Marion County, the most common are debris flows and shallow- and deep-seated landslides. 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 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).

3.3.1 Data sources

The Statewide Landslide Information Layer for Oregon (SLIDO), release 3.2 (Burns and Watzig, 2014) is an inventory of mapped landslides in the state of Oregon. SLIDO is a compilation of past studies; some studies were completed very recently using new technologies, like lidar-derived topography, and some studies were performed more than 50 years ago. Consequently, SLIDO data vary greatly in scale, scope, and focus and thus in accuracy and resolution across the state.

Burns and others (2016) used SLIDO 3.2 inventory data 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. Landslide inventory data directly define the Very High landslide susceptibility zone, whereas the landslide inventory data coupled with statistical results from generalized geology and slope maps define the other relative susceptibility zones (Burns and others, 2016). Statewide landslide susceptibility map data have the inherent limitations of SLIDO and of the generalized geology and slope maps used to create the map. Therefore, the Statewide Landslide Susceptibility Map varies significantly in quality across the state, depending on the quality 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.

Burns and Mickelson (2012) published detailed landslide inventory and susceptibility maps for the city of Silverton. DOGAMI (Harvey and Peterson, 1998; 2000; Hofmeister and others, 2000; Hofmeister and Wang, 2000) produced several landslide hazard maps in the city of Salem region approximately 20 years ago (IMS-6, IMS-5, IMS-17, IMS-18). These maps are currently part of the city of Salem's development building code. This report did not use either of these datasets and thus results in this report are different than one would obtain if these datasets were used.

Recent landslide inventory mapping in Marion County (Calhoun and others, 2020) based on lidar using methods outlined in DOGAMI Special Paper Special Paper 42 (SP-42: Burns and Madin, 2009) was published in 2020 and was not incorporated into the 2016 Statewide Landslide Susceptibility Map. For this risk assessment, we took a conservative approach and overlaid this new landslide inventory (Calhoun and others, 2020), which is equivalent to Very High susceptibility, and replaced the susceptibility zones in the Statewide Landslide Susceptibility Map (Burns and others, 2016). Areas that were previously mapped as Very High but were outside of the new landslide mapping were changed to High zones.

We used the data from the combined Statewide Landslide Susceptibility Map (Burns and others, 2016) and new landslide mapping (Calhoun and others, 2020) 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 (**Table B-6**). The total dollar value of exposed buildings was summed for the study area and is reported below. We also estimated the number of people 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

Communities that developed in terrain with moderate to steep slopes or at the base of steep hillsides may be exposed to landslides. We found that communities along the North Santiam and Santiam Rivers and Scotts Mills have a high level of exposure to landslide hazard. The percentage of building value exposed to very high and high landslide susceptibility is approximately 4.3% for the entire study area.

We combined High and Very High susceptibility zones as the primary scenarios to provide a general sense of community risk for planning purposes (**Appendix E: Plate 6**). It was useful to combine exposure for both susceptibility zones to best communicate the level of landslide risk to communities. These susceptibility zones represent areas most susceptible to landslides with the highest impact to the community.

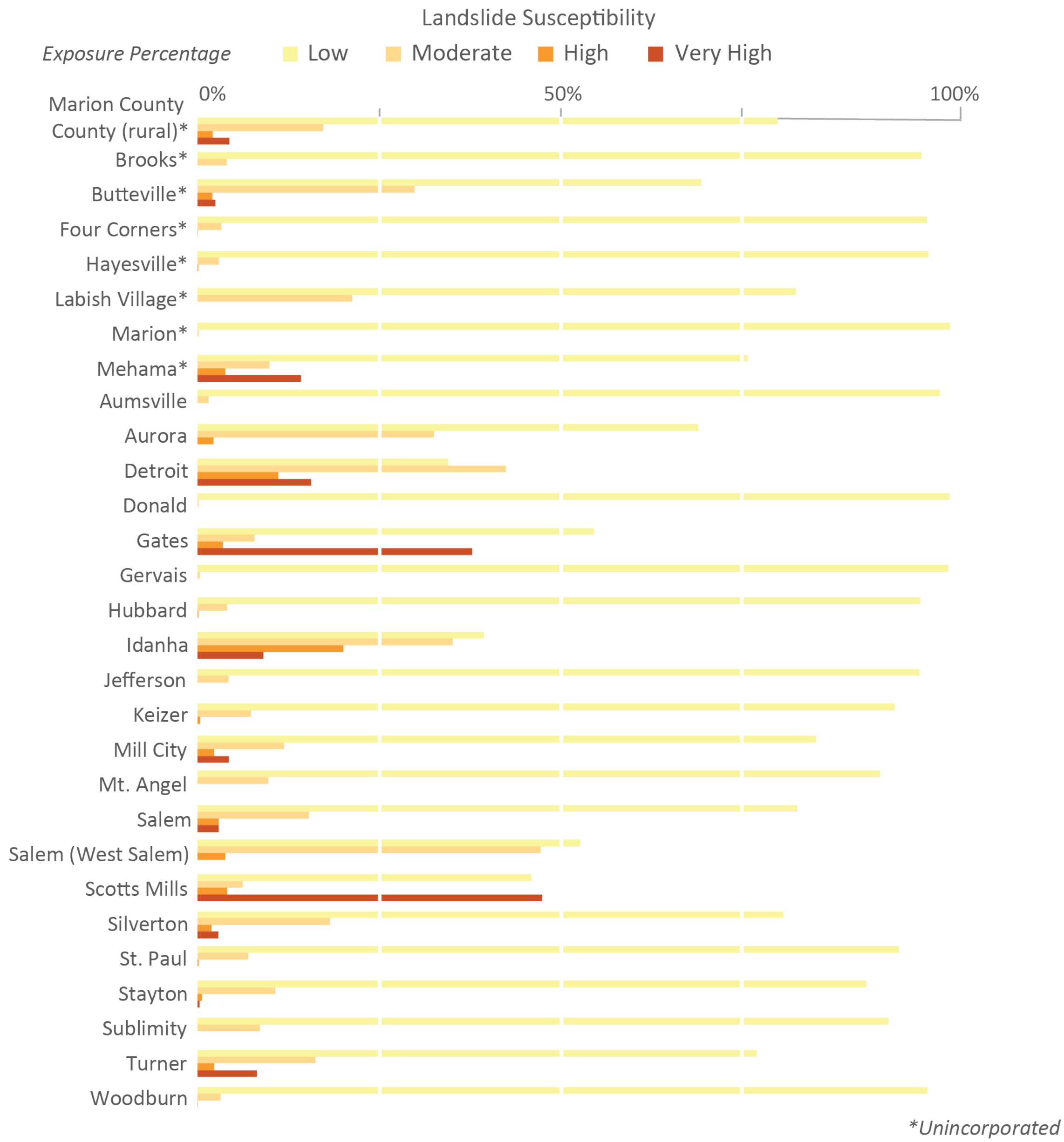
For this risk assessment we compared building locations to geographic extents of the landslide susceptibility zones (**Figure 3-5**). The exposure results shown below are for the High and Very High susceptibility zones. See **Appendix B: Detailed Risk Assessment Tables** for exposure analysis results of all susceptibility categories.

Marion countywide landslide exposure (High and Very High susceptibility):

- Number of buildings: 7,470
- Value of exposed buildings: $2,663,045,000
- Percentage of total county value exposed: 4.3%
- Critical facilities exposed: 3
- Potentially displaced population: 18,538

Most of the developed land in Marion County is located on the gentle terrain found in the Willamette River Valley, which is typically Low susceptibility landslide zones. However, there are developed areas in the southwest part of Salem, large portion of Scotts Mills, and communities along the North Santiam River that are highly susceptible to landslide hazard. Landslide hazard is ubiquitous in the eastern panhandle portion of Marion 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 Marion County.

Figure 3-5. Landslide susceptibility exposure by Marion County community.



3.3.3 Areas of significant risk

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

- Buildings in the unincorporated county along the North Santiam River are exposed to High and Very High landslide hazard.
- Many buildings in the cities of Scotts Mills and Silverton have significant exposure to High and Very High landslide hazard.
- The residential neighborhoods in the southwestern portions of Salem and just outside of Salem are built on existing landslides (mapped as Very High susceptibility).

3.4 Channel Migration

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.

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 has 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 the river to dissipate its energy over a wider area and for sediment to be deposited (Rapp and Abbe, 2003).

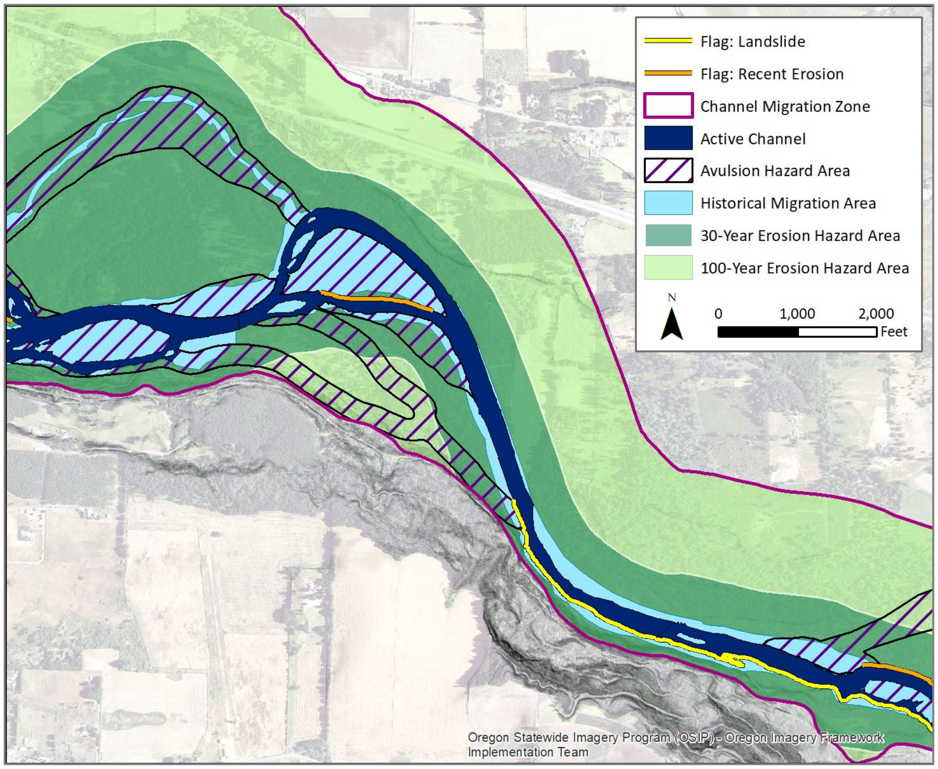
The area in which a stream channel moves laterally over a given time is known as a channel migration zone (CMZ). In places where development has occurred within the CMZ, structures are at risk for severe damage to foundations and infrastructure. The CMZ typically extends beyond the limits of the regulatory 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).

3.4.1 Data sources

The channel migration zones used for this report were developed by Appleby and others (2021) for the Pudding River and the Santiam and North Santiam Rivers. The CMZ includes the 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 3-6**).

To assess the exposure within each community, we overlaid buildings and critical facilities on the 30-year erosion hazard area within the CMZ. While there is risk throughout the CMZ, we chose to examine the structures within the 30-year erosion hazard area, because it represents the area of greatest probability of being at risk from channel migration during the next 30 years. We estimated the total dollar value of exposed buildings and the number of people potentially displaced from the 30-year CMZ and reported these values in the following section. Land value losses due to CMZ were not examined for this report.

Figure 3-6. Example diagram of the components of a channel migration zone (CMZ) map in Marion County, 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 CMZ boundary outlined in magenta (from Appleby and others, 2021).



3.4.2 Countywide results

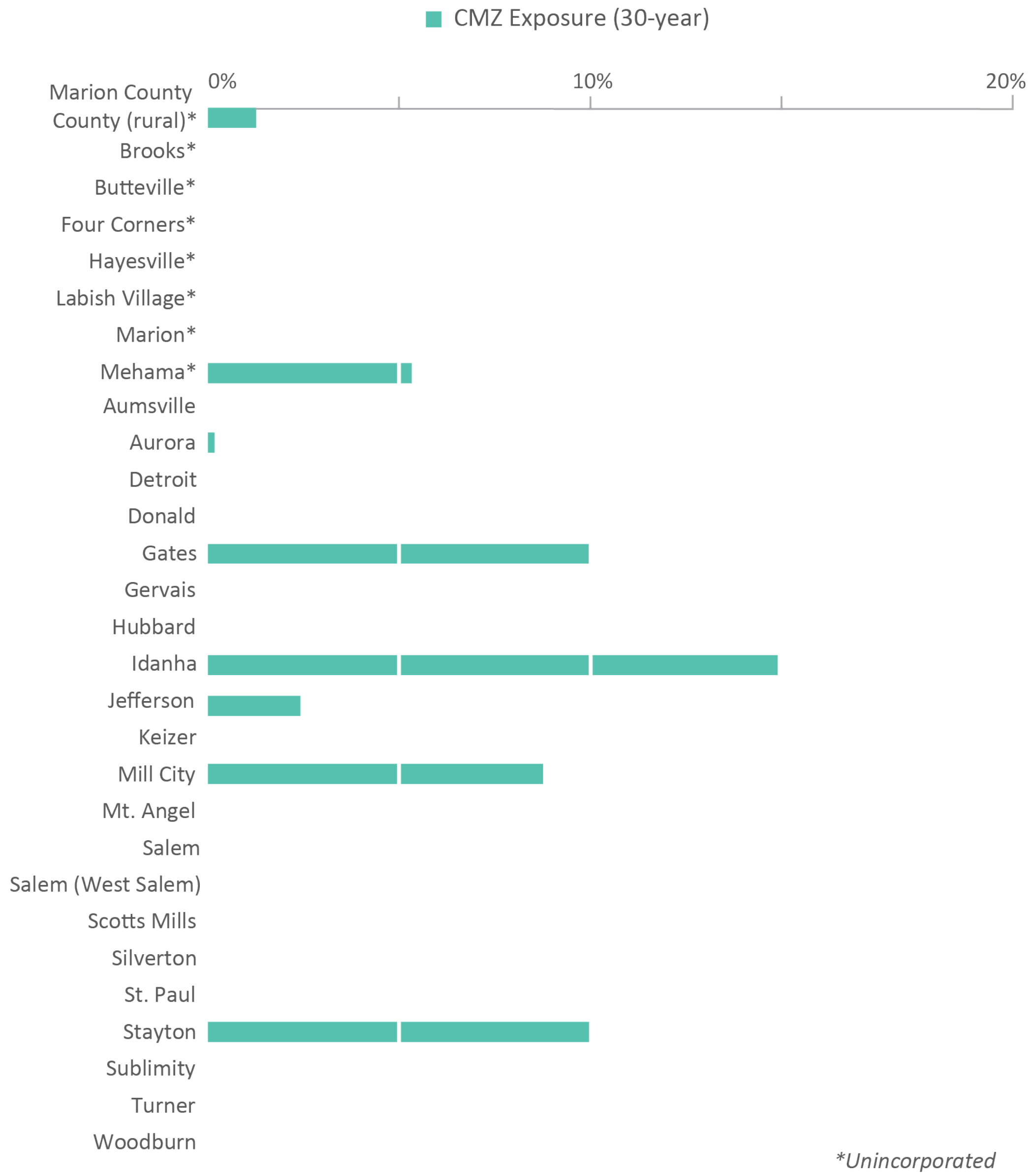
Mapped channel migration areas along the North Santiam, Santiam, and Pudding Rivers show a very high level of risk from this hazard for many communities along these watercourses. To quantify risk, the exposure analysis was conducted by determining which buildings were within or outside of the CMZ (see **Appendix E: Plate 8**). Due to the frequency of shifting channel patterns in these streams, channel migration hazard presents a significant risk compared to other hazards in the county.

Marion countywide channel migration exposure (30-year Erosion Hazard Area):

- Number of buildings: 826
- Value of exposed buildings: $295,868,000
- Percentage of total county value exposed: 0.5%
- Critical facilities exposed: 2
- Potentially displaced population: 1,475

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 half of the buildings in the city of Stayton are mapped within the potential channel migration zone. **Figure 3-7** illustrates the distribution of exposed building value due to channel migration with the different communities of Marion County. See **Appendix B: Detailed Risk Assessment Tables** for complete analysis results.

Figure 3-7. Channel migration zone exposure by Marion County community.



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 portions of the communities of Marion, Gates, Idanha, Jefferson, Mill City, and Mehama located along the Santiam and North Santiam Rivers have areas of potential risk from channel migration hazard.

- Many residential and commercial buildings are exposed to channel migration hazard in the southern portion of Stayton along the Santiam River.

3.5 Wildfire

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.

Wildfires are a natural part of the ecosystem in Oregon. However, wildfires can present a substantial hazard to life and property in growing communities. 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 geologic hazards can also present risk. These usually include flood, debris flows, and landslides. Post-wildfire geologic hazards were not evaluated in this project.

The Marion County Community Wildfire Protection Plan (WCCWPP), from 2017, recommended that the county develop policies that address 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 (MCCWPP, 2017). Contact the Marion County Planning Division for specific requirements related to the county's comprehensive plan.

As previously mentioned, Marion 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 Marion County and directly demonstrate the level of wildfire risk in the county. The Oregon Department of Emergency Management estimates that more than 1,500 structures, including 700 homes were destroyed within the study area from these wildfires.

3.5.1 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 Marion 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 risk dataset describe the level of potential impact and are characterized by very high negative values that indicate very high risk down to zero which indicates low risk. The risk dataset also includes positive values that represents 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 are present which indicates areas that have minimal risk to wildfire hazard (see **Appendix B: Table B-8**). The total dollar value of exposed buildings in the study area is reported in the following section. We also estimated the number of people threatened by wildfire. Land value losses, infrastructure, and environmental impacts due to wildfire were not examined for this project.

3.5.2 Countywide results

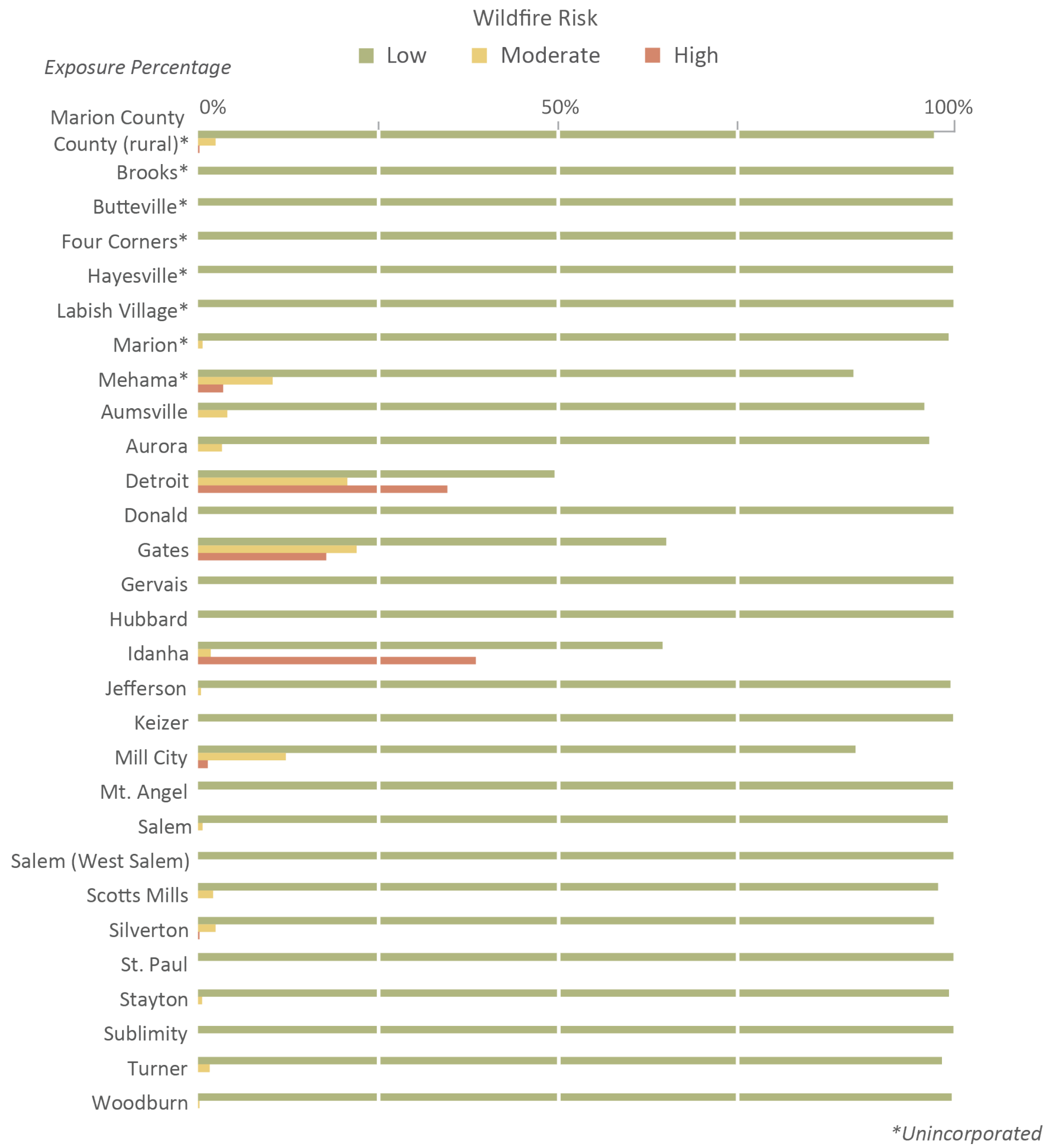
The High hazard category was chosen as the primary scenario for this report because that category represents areas that have the highest potential for losses. However, Low hazard is not the same as no hazard. Moderate wildfire risk is included with high risk in the assessment of exposure to wildfire, because under certain conditions moderate risk zones can be very susceptible to burn. In combining the High and Moderate risk categories within Marion County, we can emphasize areas where lives and property are most at risk.

Marion countywide wildfire exposure (High or Moderate risk):

- Number of buildings: 2,819
- Value of exposed buildings: $813,993,000
- Percentage of total county value exposed: 1.3%
- Critical facilities exposed: 7
- Potentially displaced population: 4,754

For this risk assessment, the building locations were compared to the geographic extent of the wildfire risk categories. More than 1,000 buildings in along the North Santiam River are exposed to High or Moderate wildfire hazard. These are the primary areas of greatest risk to this hazard, especially in heavily forested areas along state Highway 22 (**Appendix E: Plate 7**). The communities of Detroit, Idanha, Gates, and Mill City have the highest percentage of exposure to high and moderate wildfire hazard within the study area. **Figure 3-8** illustrates the level of risk from wildfire for the different communities of Marion County. See **Appendix B: Detailed Risk Assessment Tables** for multiscenario analysis results.

Figure 3-8. Wildfire risk exposure by Marion County community.



3.5.3 Areas of significant risk

We identified locations within the study area that are comparatively at greater risk from wildfire hazard:

- While the Beachie Creek, Lionshead, and P-515 wildfires that occurred in the fall of 2020 caused widespread and devastating damage to areas along the North Santiam River, those wildfires were not specifically examined in this report. However, the areas that burned will be at risk to indirect hazards such as post-wildfire debris flows, rock falls, and flash flooding. The data used in this risk assessment, both asset and hazard information, originated prior to the date of these fires. The areas most at risk based on the data used in this study correspond to areas impacted by the 2020 wildfires.
- Exposure to wildfire risk is highest for communities in the forested areas along state Highway 22 that follows along the North Santiam River.

3.6 Volcano 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. Lahars are typically generated from a volcanic eruption but can be initiated during heavy rains or by a sudden outburst of glacial melt. They are most common when a volcano that is covered with heavy loads of snow and ice erupts. When water mixes with materials from eruptions, a lahar or volcanic debris flow can occur (Driedger and Scott, 2008).

Distal volcanic hazards, as opposed to proximal volcanic hazards affect areas away from the center of geologic activity. A lahar is considered a distal volcanic hazard because a lahar can travel long distances and cause damage (Burns and others, 2011). Because a lahar moves like flowing concrete, it has the capacity to destroy most things in its path. Lahar deposits tend to exacerbate flooding and channel migration risk in the river valleys they affect (Driedger and Scott, 2008). For additional detailed information on the volcanic hazards and potential impacts, Walder and others (1999) Volcano Hazards in the Mount Jefferson Region, Oregon, USGS Open-File Report 99-24 should be reviewed. 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).

3.6.1 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**, and **Appendix E: Plate 8**). The exposure results shown below are for only the Medium scenario. We also estimated the number of people at risk from lahar hazard.

3.6.2 Countywide results

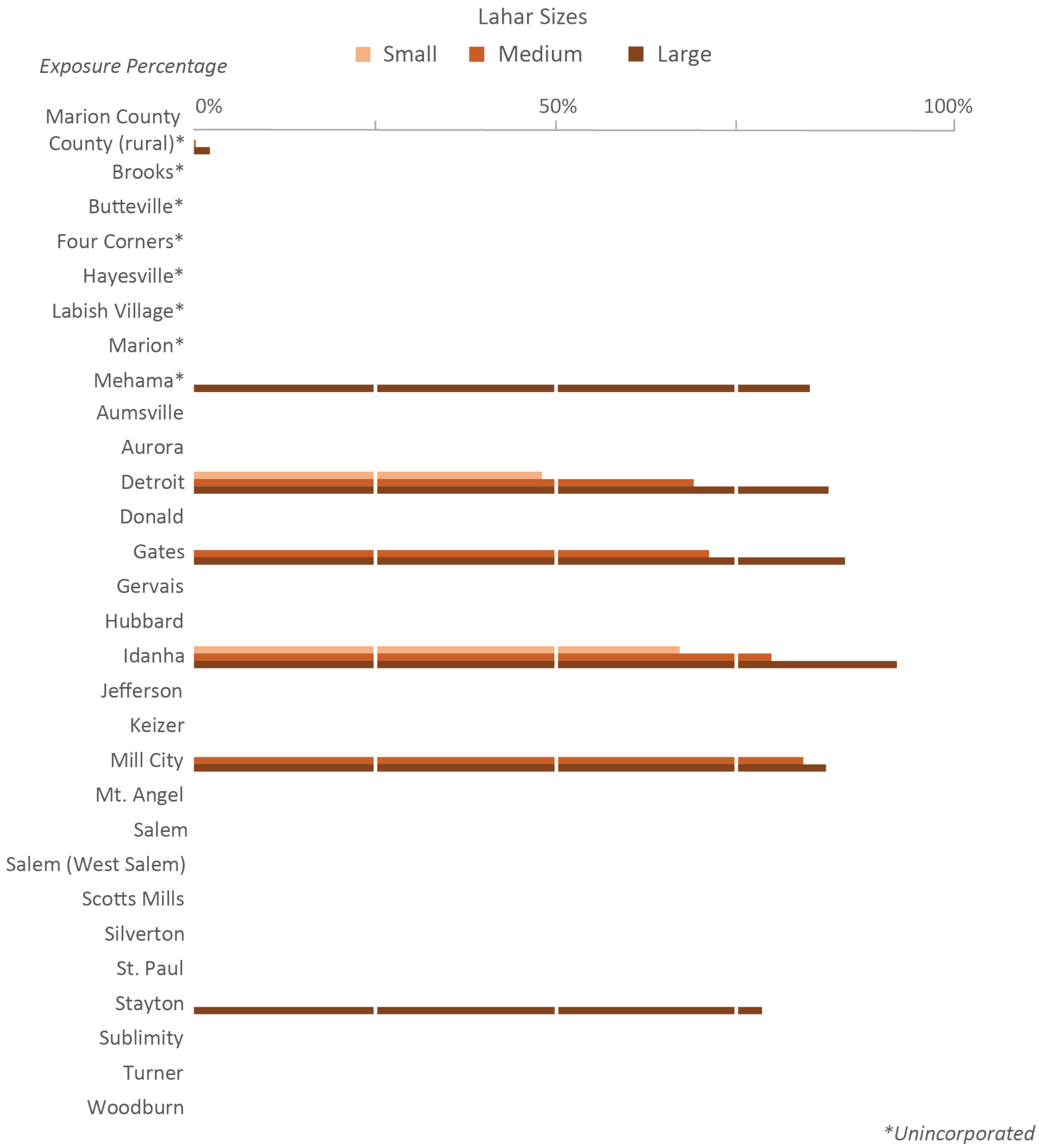
Most of the 350,000 residents in the study area are not exposed to lahar hazard, but the hazard poses significant concerns for those closer to Mount Jefferson and those within the distal riverine valley.

The total dollar value of exposed buildings was summed for the study area and is shown in **Figure 3-9**. The communities most threatened from a volcanic eruption and lahar event are Gates, Detroit, Idanha, and Mill City. See **Appendix B: Detailed Risk Assessment Tables** for cumulative multiscenario analysis results.

Marion countywide lahar exposure (Medium scenario):

- Number of buildings: 1,789
- Exposure value: $414,766,000
- Percentage of exposure value: 0.7%
- Critical facilities exposed: 3
- Potentially displaced population: 2,401

Figure 3-9. Lahar exposure by study area community.



Note that "Salem (West Salem)" is the portion of the city of Salem within Polk County. Values for "Salem" and "Salem (West Salem)" can be summed to calculate the total value for the city of Salem.

3.6.3 Areas of vulnerability or risk

We identified locations within the study area that are comparatively more vulnerable or at greater risk to lahar hazard:

- Lahar risk is present for all buildings near the North Santiam River along state Highway 22.
- The 100–1,000-year return interval is a significant threat for residents closer to Mt. Jefferson. Detroit has 47% exposure and Idanha has 66% exposure to this hazard.

4.0 CONCLUSIONS

The purpose of this study is to provide a better understanding of potential impacts from multiple natural hazards at the community scale. We accomplished this by using the latest natural hazard mapping and loss estimation tools or exposure analysis to quantify risk to buildings and potential displacement of permanent residents. 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:

- **Extensive damage and losses for some areas in Marion County can occur from an earthquake**—Based on the results of a Mt. Angel Fault Mw-6.8 earthquake, some communities in Marion County will experience at least some impact and disruption. Results show that this earthquake could cause building value losses of 30% to 35% to all communities in the northeastern portion of Marion County. The damages in this part of the county are primarily from earthquake shaking, while damage to other buildings along the Willamette, Santiam, and North Santiam Rivers could also be due to ground deformation related to liquefaction. High vulnerability within the building inventory (unreinforced masonry) also contributed to losses expected in the county.
- **Retrofitting buildings to modern seismic building codes can reduce damages and losses from earthquake shaking**—Seismic building codes have a major influence on earthquake shaking damage estimated in this study. We found that retrofitting to at least Moderate code was a very effective 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 11% to 7%. We found further reduction in estimated loss in our simulation to 5.2% by upgrading all buildings to High code. Communities with older buildings, that were constructed below the Moderate seismic code standards, are both the most vulnerable and have the greatest potential for risk reduction. For example, the city of Mt. Angel could reduce losses from 37% to 13% by retrofitting all buildings to at least moderate code. This stands in contrast to areas with newer building stock, such as the city of Keizer, which would see small reductions in damage estimates. Although seismic retrofits are an effective strategy for reducing earthquake shaking damage, it should be noted that earthquake-induced landslide and liquefaction hazards will also be present in some areas, and these hazards require 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-MH 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 10s to 100s of years versus volcanic hazards with recurrence intervals of 100s to thousands of years. We estimate that an average of 13% building value loss occurs for buildings within the 100-year flood zone. The areas that are most vulnerable from flood hazard within the study are buildings along the Mill Creek (near Salem) between Turner and Salem and along Labish Ditch in Keizer.
- **Elevating structures in the flood zone reduces vulnerability**—We used flood exposure analysis in addition to Hazus-MH 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,

we quantified the number of elevated structures within the flood zone. This showed possible mitigation needs in flood loss prevention and the effectiveness of past activities. For example, in the city of Turner nearly a third of the buildings exposed to flooding are elevated above the base flood elevation. 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 exposure analysis to assess the threat from landslide hazards. The developed areas in the southwest part of Salem, a large portion of Scotts Mills, and communities along the North Santiam River are highly susceptible to landslide hazards. Nearly 50% of the buildings in Scotts Mills are exposed to Very High or High landslide hazard.
- **Exposure analysis show that buildings in the riverine valleys of the study area are at risk from channel migration hazard—**Exposure analysis shows that channel migration hazard is a threat to communities and buildings along the Pudding, Santiam, and North Santiam Rivers. The city of Stayton has very high risk from channel migration hazard, with nearly 400 buildings exposed to the hazard.
- **Results from the wildfire risk assessment correspond to the 2020 Labor Day Wildfires along the North Santiam River—**Exposure analysis based on data prior to the 2020 wildfires show that buildings along state Highway 22 are significantly more vulnerable to wildfire hazard than the rest of the county. Hazards that are related to post-wildfire conditions, such as post-wildfire debris flow, rockfalls, and flash flooding, are likely to be present in burned areas. Post-wildfire damage assessments were not within the scope of this study, but such activities could offer a better understanding to limit future risk.
- **Exposure analysis shows that communities along the North Santiam River are at risk to lahar hazard—**Exposure analysis shows that volcanic lahar hazard is a minor threat to some communities in the study area. Structures near the North Santiam River along state Highway 22 are most at risk to lahar compared to other parts of the study area. In the community of Detroit and Idanha there are 47% and 66%, respectively, of buildings exposed to the 100- to 1,000-year return interval of lahar hazard.
- **Many of the study area's critical facilities are at significant risk to earthquake and channel migration—**Critical facilities were identified and were specifically examined within this report. We have estimated that 35% (85 of 236) of Marion County's critical facilities will be non-functioning after a Mt. Angel Fault Mw-6.8 earthquake. Additionally, 8% (20 of 236) of critical facilities are exposed to channel migration hazard and 4% (11 of 236) to flood hazard. We found little exposure of critical facilities to landslide, wildfire, and lahar hazards.
- **The biggest causes of displacement to population are earthquake and landslide hazards—** Potential displacement of permanent residents from natural hazards was estimated within this report. We estimated that there is risk to 5.3% of the population in the county from landslide hazard (not a single hazard event) and 4.3% from an earthquake. Channel migration hazard is a potential threat to 1.8% of permanent residents. A small percentage of residents are vulnerable to displacement from flood, wildfire, and lahar hazards.
- **The results allow communities the ability to compare across hazards and prioritize their needs—**Each community within the study area was assessed for natural hazard exposure and loss. This allowed 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 for 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 the 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-MH 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 unreinforced 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-MH 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 Marion County have a number of vacation homes and rentals, which are typically occupied during the summer. Our estimates of potentially displaced people rely on permanent populations published in the 2010 U.S. Census (United States Census Bureau, 2010b) and adjusted for population growth 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 assessments 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 were 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 problems was 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.

6.0 RECOMMENDATIONS

The following areas of implementation 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

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 becomes a safer place to live. Awareness and preparation not only reduce the initial impact from natural hazards, but they also reduce the amount of recovery time for a after a disaster—this ability is 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 and local community organizations that partner with local officials in the development of additional effective resources could help this information reach a wider audience.

6.2 Planning

Local decision-makers can make plans based on the geohazard and risk information presented in this report. The primary framework for accomplishing this is through the comprehensive planning process. A 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. The information presented in this report is a key resource because it directly informs the vulnerability assessment section of the NHMP plan.

While there are many similarities between this report and an NHMP, the hazards or critical facilities in the two reports can vary. 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-MH for non-building structures and to different considerations about emergency response during and after a disaster.

6.3 Emergency Response

Critical facilities play a major role during and immediately after a natural disaster. This study can help emergency managers identify vulnerable critical facilities and develop contingencies in their response plans. Additionally, detailed mapping of potentially displaced residents can be used to reevaluate evacuation routes and identify vulnerable populations to assist with early warning.

The building database that accompanies this report can guide predisaster mitigation, emergency response, and community resilience improvements. Vulnerable areas can be identified and supported through awareness campaigns. These campaigns can be aimed at predisaster mitigation actions, such as seismic retrofitting. 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. Reduction of the magnitude of the disaster, emergency planning, and improved response time contribute to a community's natural hazard resilience.

6.4 Mitigation Funding Opportunities

Several funding sources are available to communities that are susceptible to natural hazards and have specific mitigation projects they wish to accomplish. State and federal funds are available for projects that demonstrate cost effective natural hazard risk reduction. 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.

At the time of writing this report, FEMA has three programs that assist states, local communities, tribes, and territories with natural hazard mitigation funding: Hazard Mitigation Grant Program (HMGP) Building Resilient Infrastructure and Communities (BRIC), and Pre-Disaster Mitigation (PDM) Grant Program. FEMA also has a grant program specifically for flooding called Flood Mitigation Assistance (FMA). 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 35% of critical facilities (**Appendix A: Community Risk Profiles**) will be damaged by an 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 floodwater 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 landslide 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 Pudding River, the Santiam, and North Santiam Rivers, should include 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 multipurpose including areas that provide or improve floodwater storage, riparian and aquatic habitat restoration, and climate change resilience, and water quality.

6.5.5 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.

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9.0 APPENDICES

APPENDIX A. COMMUNITY RISK PROFILES

A risk analysis summary for each community is provided in this section to encourage ideas for natural hazard risk reduction. 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. This appendix contains community specific data to provide an overview of the community and the level of risk from each natural hazard analyzed. In addition, for each community a list of critical facilities and assumed impact from individual hazards is provided.

A.1 Unincorporated Marion County (Rural)

Table A-1. Unincorporated Marion County (rural) hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Unincorporated Marion County (rural)	47,599	43,387	54	16,042,238,000

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	205	0.4%	247	1	9,060,000	0.1%
Earthquake	Mt. Angel Mw-6.8 Deterministic	1,794	3.8%	7,868	25	2,169,985,170	14%

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	4,282	9.0%	3,132	2	1,000,718,000	6.2%
Channel Migration	Channel Migration Zone	263	0.6%	288	0	90,300,000	0.6%
Wildfire	High and Moderate Risk	1,671	3.5%	1,550	3	416,940,000	2.6%
Lahar	Medium Zone (1,000 to 15,000-year)	152	0.3%	175	0	43,913,000	0.3%

[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 Marion County (rural) critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Abiqua School						
Ames Municipal Airport						
Aurora Sewage Treatment Plant						
Aurora State Airport		X				
Bethany Charter School		X				
Bethel Elementary School		X				
Brooks Sewage Treatment Plant		X				
Cascade JR/SR High School						
Central Howell Elementary School		X				
Cloverdale Elementary School						
Crosshill Christian School						
Detroit Ranger Station			X		X	
Drakes Crossing RFPD		X				
Drift Creek Station						
Elkhorn Station			X		X	
Evergreen Elementary School		X				
Fruitland Elementary School		X				
Harchenko Industrial Airport						
Holy Family Academy		X				
Jefferson Christian School						
Jefferson High School						
Jefferson Middle School						
Jefferson Sewage Water Treatment	X					
Lake Labish Elementary School						
Livingstone Adventist Academy						
Marion County Emergency Operations Center						
Marion County Fire District 1 - Brooklake Station 5						
Marion County Fire District 1 - Four Corners Station 1		X				
Marion County Fire District 1 - Labish Station 7		X				
Marion County Fire District 1 - Macleay Station 4						
Marion County Fire District 1 - Pratum Station 3						
Marion County Public Works						
Monitor Elementary School						
Monitor RFPD 58						
Mt Angel Sewage Treatment Plant						
North Marion Intermediate School						
North Marion Middle School						

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
North Marion Primary School						
North Marion SR High School						
Pioneer Elementary School						
Pratum Elementary School						
St. John Bosco High School		X				
St. Paul Substation		X				
Sacred Heart Catholic School						
Silver Crest Elementary School						
Silverton RFPD - Abiqua Station						
Silverton RFPD - Crooked Finger Station					X	
Silverton RFPD - Victor Point Station						
Talbot Station						
Valley Inquiry Charter School						
Victor Point Elementary						
William P Lord High School		X				
Woodburn RFPD 6 - Station 24 Waconda						
Woodburn RFPD 6 - Station 25 Broadacres						

A.2 Unincorporated Community of Brooks

Table A-3. Unincorporated community of Brooks hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Brooks	272	249	2	89,505,000

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	0.0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	14	5.1%	61	0	13,149,525	14.7%

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	0	0%	0	0	0	0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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-4. Unincorporated community of Brooks critical facilities.

Critical Facilities by Community	Flood 1% Annual Chance Exposed	Earthquake Moderate to Complete Damage >50% Prob.	Landslide High and Very High Susceptibility Exposed	Channel Migration Zone Exposed	Wildfire High or Moderate Risk Exposed	Lahar Medium Hazard Zone Exposed
Brooks School						
Willamette Valley Christian School						

A.3 Unincorporated Community of Butteville

Table A-5. Unincorporated community of Butteville hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Butteville	352	193	0	78,691,000

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	Mt. Angel Mw-6.8 Deterministic	18	5.2%	56	0	13,144,000	17%

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	4.2%	10	0	3,393,000	4.3%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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.4 Unincorporated Community of Four Corners

Table A-6. Unincorporated community of Four Corners hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Four Corners	9,385	6,508	3	1,801,596,000

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	Mt. Angel Mw-6.8 Deterministic	199	2.1%	558	1	86,297,683	4.8%

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%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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-7. Unincorporated community of Four Corners critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Channel Migration Zone**	**Wildfire High or Moderate Risk**	**Lahar Medium Hazard Zone**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Auburn Elementary School						
Four Corners Elementary School		X				
Mary Eyre Elementary School						

A.5 Unincorporated Community of Hayesville

Table A-8. Unincorporated community of Hayesville hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Hayesville	11,677	7,876	7	2,382,452,000	

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	Mt. Angel Mw-6.8 Deterministic	333	2.8%	954	2	158,024,983	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	14	0.1%	6	0	2,218,000	0.1%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	7	0%	7	0	1,209,000	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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-9. Unincorporated community of Hayesville critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Early College High School						
Grace Academy		X				
Hayesville Elementary School		X				
Lamb Elementary School						
Marion County Fire District 1 - Chemeketa Station 8						
Middle Grove Elementary School						
Scott Elementary School						

A.6 Unincorporated Community of Labish Village

Table A-10. Unincorporated community of Labish Village hazard profile.

Community Overview

Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Labish Village	232	167	0	43,407,000

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	Mt. Angel Mw-6.8 Deterministic	4	1.9%	18	0	3,210,885	7.4%

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%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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.7 Unincorporated Community of Marion

Table A-11. Unincorporated community of Marion hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Marion	230	244	0	64,728,000

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	Mt. Angel Mw-6.8 Deterministic	0	0.1%	4	0	875,700	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%	0	0	0	0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	3	1.3%	1	0	408,000	0.6%
Lahar	Medium Zone (1,000 to 15,000-year)	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-12. Unincorporated community of Marion critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Marion Fire Station						

A.8 Unincorporated Community of Mehama

Table A-13. Unincorporated community of Mehama hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Mehama	203	189	1	53,460,000

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	Mt. Angel Mw-6.8 Deterministic	3	1.3%	17	0	3,014,033	5.6%

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	42	21%	29	0	9,312,000	17%
Channel Migration	Channel Migration Zone	8	3.9%	12	0	3,051,000	5.7%
Wildfire	High and Moderate Risk	36	18%	28	0	7,074,000	13%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0%	0	1	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-14. Unincorporated community of Mehama critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Mehama Fire Station						X

A.9 City of Aumsville

Table A-15. City of Aumsville hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Aumsville	4,215	1,459	5	509,635,000

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%	6	0	76,000	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	36	0.9%	93	2	16,580,652	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	0.0%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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-16. City of Aumsville critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Hazard
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Aumsville Elementary School						
Aumsville Police Department						
Aumsville RFPO		X				
Aumsville Sewage Treatment Plant		X				
Willamette Valley Baptist School						

A.10 City of Aurora

Table A-17. City of Aurora hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Aurora	985	560	2	258,763,000

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%	2	0	7,000	0%
Earthquake	Mt. Angel Mw-6.8 Deterministic	32	3.3%	100	2	31,708,988	12%

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	27	2.7%	15	0	5,511,000	2.1%
Channel Migration	Channel Migration Zone	0	0%	1	0	118,000	0.05%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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-18. City of Aurora critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Aurora Police Department		X				
Aurora RFPD - Aurora Station		X				

A.11 City of Detroit

Table A-19. City of Detroit hazard profile.

Community Overview							
Community Name		Population	Number of Buildings	Critical Facilities[1]		Total Building Value ($)	
Detroit		205	315	1		69,925,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	0	0%	2	0	186,986	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	52	26%	78	0	18,032,000	26%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	120	59%	185	0	36,915,258	53%
Lahar	Medium Zone (1,000 to 15,000-year)	128	62%	198	0	47,132,000	67%

[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 Detroit critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Detroit Fire Station						

A.12 City of Donald

Table A-21. City of Donald hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Donald	995	490	1	195,528,000	

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*	Mt. Angel Mw-6.8 Deterministic	181	18%	221	1	57,784,232	30%

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	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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-22. City of Donald critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Aurora RFPD - Donald Station		X				

A.13 City of Gates

Table A-23. City of Gates hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Gates	540	326	1	71,352,000	

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*	Mt. Angel Mw-6.8 Deterministic	6	1.1%	20	0	2,291,112	3.2%

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	231	43%	151	0	28,397,000	40%
Channel Migration	Channel Migration Zone	53	10%	27	0	7,145,000	10%
Wildfire	High and Moderate Risk	212	39%	124	1	27124398	38%
Lahar	Medium Zone (1,000 to 15,000-year)	369	68%	216	1	49,569	70%

[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 Gates critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Gates Main Station					X	X

A.14 City of Gervais

Table A-25. City of Gervais hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Gervais	2,620	719	3	247,297,000	

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*	Mt. Angel Mw-6.8 Deterministic	397	15%	266	4	55,400,740	22%

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	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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-26. City of Gervais critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Channel Migration Zone**	**Wildfire High or Moderate Risk**	**Lahar Medium Hazard Zone**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
City Hall		X				
Gervais High School		X				
Gervais Middle School		X				

A.15 City of Hubbard

Table A-27. City of Hubbard hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Hubbard	3,315	1,187	3	458,199,000	

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*	Mt. Angel Mw-6.8 Deterministic	379	11%	466	3	125,813,507	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	6	0.2%	2	0	594,000	0.1%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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-28. City of Hubbard critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Hubbard Police Department		X				
Hubbard RFPD		X				
Hubbard Sewage Treatment Plant		X				

A.16 City of Idanha

Table A-29. City of Idanha hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Idanha	155	159	1	35,338,000

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	3	1.7%	2	0	23,000	0.1%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	0	0.1%	1	0	149,000	0.4%

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	28	18%	39	0	9,935,000	28%
Channel Migration	Channel Migration Zone	23	15%	21	0	4,094,000	15%
Wildfire	High and Moderate Risk	79	51%	66	0	13610108	39%
Lahar	Medium Zone (1,000 to 15,000-year)	141	91%	127	0	27,525,000	78%

[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 Idanha critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Idanha-Detroit RFPD						

A.17 City of Jefferson

Table A-31. City of Jefferson hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Jefferson		3,280	1,243		2	389,441,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	5	0.1%	2	0	8,000	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	2	0.1%	12	0	3,211,000	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	0.0%
Channel Migration	Channel Migration Zone	62	1.9%	25	0	8,146,000	2.1%
Wildfire	High and Moderate Risk	15	0.5%	4	0	1,626,000	0.4%
Lahar	Medium Zone (1,000 to 15,000-year)	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-32. City of Jefferson critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Jefferson Elementary School						
Jefferson Main Station				X		

A.18 City of Keizer

Table A-33. City of Keizer hazard profile.

Community Overview							
Community Name		Population	Number of Buildings	Critical Facilities[1]		Total Building Value ($)	
Keizer		38,585	16,380	15		5,592,798,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	704	1.8%	336	0	26,571,000	0.5%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	2,479	6.4%	3,994	5	722,048,109	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	142	0.4%	62	0	18,852,000	0.3%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	17	0.0%	6	0	2190893	0.0%
Lahar	Medium Zone (1,000 to 15,000-year)	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 Keizer critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Centennial School		X				
Claggett Creek Middle School						
Clear Lake Elementary						
Cummings Elementary School		X				
Forest Ridge Elementary School						
Gubser Elementary						
Keizer Elementary		X				
Keizer Fire District		X				
Keizer Police Department		X				
Kennedy Elementary School						
Clearlake Station 6						
McNary High School						
Urgent Care Inland Shores						
Weddle Elementary School						
Whiteaker Middle School						

A.19 City of Mill City

Table A-35. City of Mill City hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Mill City	1,915	1,269	3	299,237,000	

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*	Mt. Angel Mw-6.8 Deterministic	5	0.3%	17	0	4,876,531	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	126	6.6%	78	0	19,040,000	6.4%
Channel Migration	Channel Migration Zone	196	10%	72	0	25,451,000	8.5%
Wildfire	High and Moderate Risk	260	14%	171	2	38745652	13%
Lahar	Medium Zone (1,000 to 15,000-year)	1,604	84%	1,069	3	245,855	82%

[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 Mill City critical facilities.

	Flood 1% Annual Chance	**Earthquake Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Channel Migration Zone**	**Wildfire High or Moderate Risk**	**Lahar Medium Hazard Zone**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Mill City Main Station					X	X
Santiam Elementary					X	X
Santiam JR SR High School						X

A.20 City of Mt. Angel

Table A-37. City of Mt. Angel hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Mt. Angel		3,520	1,219		7	539,815,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0%	0	0	0	0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	613	17%	553	1	197,469,572	37%
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	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	2	0	87,000	0%
Lahar	Medium Zone (1,000 to 15,000-year)	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-38. City of Mt. Angel critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
John F Kennedy SR High School		X				
Mount Angel Fire Department						
Mount Angel Police Department						
Mount Angel Public Works						
Mt Angel Middle School						
Silverton - Mt Angel Family Medicine						
St Mary's Public School						

A.21 City of Salem

Table A-39. City of Salem hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Salem	141,565	58,163	80	22,532,083,000	

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	2,571	1.8%	1,431	8	70,473,000	0.3%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	1,924	1.4%	3,591	5	1,044,527,904	4.6%

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	11,252	7.9%	2,927	1	1,261,015,000	5.6%
Channel Migration	Channel Migration Zone	0	0.0%	0	0	0	0.0%
Wildfire	High and Moderate Risk	1,555	1.1%	432	0	170035265	0.8%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	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-40. City of Salem critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Armed Forces Reserve Center						
Baker Elementary School						
Battle Creek Elementary	X					
Blanchet Catholic School						
Bush Elementary School		X				
Candalara Elementary School						
Chavez Elementary						
Chemawa Indian School		X				
Crossler Middle School						
Eagle Charter School						
Englewood Elementary School		X				
Grant Community School						
Hallman Elementary School						
Hammond Elementary School		X				
Heritage School						
Highland Elementary School						
Hoover Elementary School						
Houck Middle School						
Immanuel Evangelical Lutheran School						
Judson Middle School						
Lee Elementary School						
Leslie Middle School						
Liberty Elementary School						
Marion County Community Corrections		X				
McKay High School						
McKinley Elementary School						
McNary Army Aviation Hangars	X					
McNary Field	X					
MG George A White Building						
Military Department						
Miller Elementary School						
Montessori Discovery Center						
Morningside Elementary School						
North Salem High School	X					
Oregon Dept of Transportation	X					
Oregon Emergency Management						
Oregon State Hospital						
Oregon State Police	X					
Oregon State Police – Capitol Office						

Critical Facilities by Community	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
Oregon Youth Authority - Hillcrest Youth Corrections						
Parrish Middle School						
Pringle Elementary School						
Queen of Peace School						
Richmond Elementary School						
Roberts High School						
St John Lutheran School						
St Joseph School						
Salem Academy Christian School						
Salem Child Development Center						
Salem Clinic Main						
Salem Clinic South						
Salem Emergency Services						
Salem Fire Dept - Station 01						
Salem Fire Dept - Station 02						
Salem Fire Dept - Station 03						
Salem Fire Dept - Station 04						
Salem Fire Dept - Station 07						
Salem Fire Dept - Station 09						
Salem Fire Dept - Station 10						
Salem Heights Elementary School						
Salem Hospital	X					
SALEM KINDERCARE						
Salem Montessori School						
Salem Police Department						
Salem Public Works	X					
Schirle Elementary School						
SONSHINE CHRISTIAN SCHOOL						
South Salem High School			X			
Sprague High School						
St Vincent Depaul School						
Stephens Middle School						
Sumpter Elementary School						
Swegle Elementary School						
Urgent Care Clinic South						
Waldo Middle School						
WASHINGTON ELEMENTARY SCHOOL						
Wright Elementary School						
Yakima Valley Farm Workers Clinic						
Yoshikai Elementary School						
Zoom Care Salem						

A.22 City of Salem (West Salem)

Table A-41. City of Salem (West Salem) hazard profile.

Community Overview							
Community Name		Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)		
Salem (West Salem)		27,405	10,797	12	3,194,904,000		
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	361	1.3%	157	0	12,098,000	0.4%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	758	2.8%	580	1	132,316,114	4.1%
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	1,104	4.0%	424	0	117,055,000	3.7%
Channel Migration	Channel Migration Zone	4	0.0%	1	0	428,000	0.0%
Wildfire	High and Moderate Risk	0	0.0%	0	0	0	0.0%
Lahar	Medium Zone (1,000 to 15,000-year)	7	0.0%	4	0	772	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-42. City of Salem (West Salem) critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Brush College Elementary School		X				
Chapman Hill Elementary School						
Harrit Elementary School						
Kalapuya Elementary School						
Myers Elementary School						
Riviera Christian School						
Salem Fire Dept - Station 05						
Salem Fire Dept - Station 11						
Straub Middle School						
Walker Middle School						
West Salem Clinic						
West Salem High School						

A.23 City of Scotts Mills

Table A-43. City of Scotts Mills hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Scotts Mills	385	242	2	63,043,000	

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	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	96	24.9%	118	0	16,983,461	26.9%

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	234	61%	140	0	31,315,000	50%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	15	3.9%	7	0	1280323	2.0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	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-44. City of Scotts Mills critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Scotts Mills Elementary School						
Silverton RFPD - Scotts Mills Station						

A.24 City of Silverton

Table A-45. City of Silverton hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]		Total Building Value ($)
Silverton		10,520	4,077		13		1,740,060,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	81	0.8%	12	0	1,861,000	0.1%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	1,107	10.5%	1,406	1	427,198,866	24.6%
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	568	5.4%	188	0	80,361,000	4.6%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	336	3.2%	106	0	44651351	2.6%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	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-46. City of Silverton critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Evergreen Surgeons - Walter Harris						
Family Medical Group Silverton		X				
Mark Twain JR High School						
Northwest Family Medicine						
Robert Frost Elementary School						
Silverton - McClaine Street Clinic						
Silverton Christian School						
Silverton High School						
Silverton Hospital						
Silverton Middle School						
Silverton Police Department						
Silverton Public Works						
Silverton RFPD - Headquarters						

A.25 City of St. Paul

Table A-47. City of St. Paul hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
St. Paul	440	247	4	132,631,000

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	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	10	2.2%	40	0	14,607,033	11.0%

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%	1	0	220,000	0.2%
Channel Migration	Channel Migration Zone	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0.0%	0	0	0	0.0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	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-48. City of St. Paul critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	Exposed	>50% Prob.	Exposed	Exposed	Exposed	Exposed
St Paul Elementary School						
St Paul High School						
St Paul Parochial School						
St Paul RFPD						

A.26 City of Stayton

Table A-49. City of Stayton hazard profile.

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]		Total Building Value ($)
Stayton		7,880	3,043		12		1,546,547,000
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	1	0.0%	2	0	33,000	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	62	0.8%	150	0	64,342,531	4.2%
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	97	1.2%	32	0	13,290,000	0.9%
Channel Migration	Channel Migration Zone	866	11%	379	2	157,134,000	10%
Wildfire	High and Moderate Risk	50	0.6%	22	2	9113578	0.6%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	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-50. City of Stayton critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Regis High School					X	
Santiam Memorial Hospital - Stayton						
St Mary's Catholic School						
Stayton Christian School						
Stayton City Shops						
Stayton Elementary School						
Stayton Emergency Services						
Stayton High School					X	
Stayton Middle School						
Stayton Police Department				X		
Stayton RFPD						
Stayton Water Treatment Plant				X		

A.27 City of Sublimity

Table A-51. City of Sublimity hazard profile.

Community Overview					
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)	
Sublimity	3,050	1,157	4	546,449,000	

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	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	6	0.2%	19	0	7,850,753	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	0.0%	0	0	0	0.0%
Channel Migration	Channel Migration Zone	0	0.0%	0	0	0	0.0%
Wildfire	High and Moderate Risk	0	0.0%	0	0	0	0.0%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	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-52. City of Sublimity critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Sublimity Elementary School						
Sublimity Middle School						
Sublimity Public Works						
Sublimity RFPD						

A.28 City of Turner

Table A-53. City of Turner hazard profile.

Community Overview							
Community Name		Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)		
Turner		2,410	1,365	3	421,185,000		
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	596	24.7%	347	1	5,849,000	1.4%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	9	0.4%	55	0	11,885,560	2.8%
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	300	13%	149	0	42,486,000	10%
Channel Migration	Channel Migration Zone	0	0.0%	0	0	0	0.0%
Wildfire	High and Moderate Risk	50	2.1%	28	0	6515452	1.5%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	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-54. City of Turner critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
Turner Elementary School						
Turner Fire Department	X					
Turner Police Department						

A.29 City of Woodburn

Table A-55. City of Woodburn hazard profile.

Community Overview				
Community Name	Population	Number of Buildings	Critical Facilities[1]	Total Building Value ($)
Woodburn	25,185	7,332	17	3,446,910,000

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	41	0.2%	8	0	266,000	0.0%
Earthquake*	Mt. Angel Mw-6.8 Deterministic	4,595	18.2%	3,270	4	1,287,042,534	37.3%

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	0.1%	5	0	1,224,000	0.0%
Channel Migration	Channel Migration Zone	0	0.0%	0	0	0	0.0%
Wildfire	High and Moderate Risk	87	0.3%	20	0	8217418	0.2%
Lahar	Medium Zone (1,000 to 15,000-year)	0	0.0%	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-56. City of Woodburn critical facilities.

	Flood 1% Annual Chance	Earthquake Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk	Lahar Medium Hazard Zone
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**Exposed**	**Exposed**	**Exposed**	**Exposed**
French Prairie Middle School		X				
Gethsemane Christian Academy		X				
Heritage Elementary School		X				
Legacy Medical Group - Woodburn		X				
Lincoln Elementary School		X				
Nellie Muir Elementary School						
Salud Medical Center						
Silverton - Woodburn Immediate Care and Family Medicine						
Silverton - Woodburn Internal Medicine						
St Luke's School						
Valor Middle School						
Woodburn Arthur Academy						
Woodburn Family Medicine						
Woodburn High School						
Woodburn Police Department						
Woodburn Public Works						
Woodburn RFPD 6 - Station 21 HQ						
Woodburn RFPD 6 - Station 22 James Street						
Woodburn Success High School						

APPENDIX B. DETAILED RISK ASSESSMENT TABLES

Table B-1. Marion County building inventory.

(all dollar amounts in thousands)

	Residential			Commercial and Industrial			Agricultural			Public and Nonprofit			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 Watershed Total	Building Value ($)	Value of Buildings per Watershed Total
Unincorp. Marion Co (rural)	20,033	7,206,367	45%	719	858,042	5.3%	22,199	7,441,292	46%	436	536,537	3.3%	43,387	25%	16,042,238	26%
Brooks	156	37,487	42%	27	17,240	19.3%	58	14,603	16%	8	20,175	22.5%	249	0.1%	89,505	0.1%
Butteville	116	55,557	71%	1	474	0.6%	74	21,203	26.9%	2	1,456	1.9%	193	0.1%	78,691	0.1%
Four Corners	4,336	1,449,611	80%	177	200,238	11.1%	1,967	96,170	5.3%	28	55,578	3.1%	6,508	3.8%	1,801,596	2.9%
Hayesville	5,038	1,848,581	78%	207	197,850	8%	2,502	121,144	5.1%	129	214,877	9.0%	7,876	4.6%	2,382,452	3.8%
Labish Village	138	36,978	85%	9	3,475	8.0%	19	2,158	5.0%	1	796	1.8%	167	0%	43,407	0%
Marion	125	35,697	55%	2	597	0.9%	114	24,616	38.0%	3	3,817	6%	244	0.1%	64,728	0.1%
Mehama	114	30,536	57%	18	10,838	20%	55	10,609	20%	2	1,476	3%	189	0.1%	53,460	0.1%
Total Unincorp County	30,056	10,700,813	52%	1,160	1,288,755	6%	26,988	7,731,795	37.6%	609	834,713	4%	58,813	34.5%	20,556,076	32.7%
Aumsville	1,283	384,099	75%	50	43,934	9%	104	28,682	6%	22	52,919	10%	1,459	0.9%	509,635	0.8%
Aurora	428	169,434	65%	60	37,293	14%	65	45,575	18%	7	6,460	2.5%	560	0.3%	258,763	0.4%
Detroit	242	54,049	77%	11	4,215	6%	55	7,943	11.4%	7	3,718	5%	315	0%	69,925	0%
Donald	359	82,831	42%	32	80,527	41%	94	29,610	15%	5	2,560	1.3%	490	0%	195,528	0%
Gates	206	48,934	69%	6	3,639	5%	112	18,036	25%	2	743	1%	326	0%	71,352	0%
Gervais	637	182,425	74%	13	13,617	6%	46	4,930	2%	23	46,325	19%	719	0%	247,297	0%
Hubbard	962	293,470	64%	141	150,652	4%	75	7,476	2%	9	6,602	1%	1,187	1%	458,199	1%
Idanha	94	19,141	54%	14	9,160	26%	46	6,000	17%	5	1,037	3%	159	0%	35,338	0%
Jefferson	1,060	321,719	83%	35	19,728	5%	130	26,216	7%	18	21,778	6%	1,243	1%	389,441	1%
Keizer	11,877	4,758,762	85%	393	360,465	6%	3,993	210,603	4%	117	262,968	5%	16,380	10%	5,592,798	9%
Mill City	884	233,300	78%	27	11,726	4%	339	21,704	7%	19	32,507	11%	1,269	1%	299,237	0%
Mt. Angel	941	345,131	64%	69	87,703	16%	153	22,087	4%	56	84,893	16%	1,219	1%	539,815	1%
Salem	40,365	14,640,969	65%	3,364	5,133,496	23%	13,261	733,938	3%	1,173	2,023,679	9%	58,163	34%	22,532,083	36%

(all dollar amounts in thousands)

	Residential			Commercial and Industrial			Agricultural			Public and Nonprofit			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 Watershed Total**	**Building Value ($)**	**Value of Buildings per Watershed Total**
Salem (West Salem)	10,106	2,784,458	87%	220	174,429	5%	407	21,552	1%	64	214,465	7%	10,797	6%	3,194,904	5%
Scotts Mills	149	39,987	63%	5	1,226	2%	78	12,337	20%	10	9,494	15%	242	0%	63,043	0%
Silverton	3,426	1,285,699	74%	186	235,685	14%	385	53,125	3%	80	165,551	10%	4,077	2%	1,740,060	3%
St. Paul	155	65,091	49%	14	13,122	10%	63	25,634	19%	15	28,784	22%	247	0%	132,631	0%
Stayton	2,463	963,861	62%	243	401,864	26%	256	48,559	3%	81	132,263	9%	3,043	2%	1,546,547	2%
Sublimity	979	486,698	89%	35	25,793	5%	128	16,869	3%	15	17,089	3%	1,157	1%	546,449	1%
Turner	822	287,771	68%	99	66,333	16%	383	27,530	7%	61	39,552	9%	1,365	1%	421,185	1%
Woodburn	6,469	2,223,170	64%	388	887,455	26%	352	77,309	2%	123	258,975	8%	7,332	4%	3,446,910	5%
Total Study Area	113,963	40,371,813	64%	6,565	9,050,817	14%	47,513	9,177,510	15%	2,521	4,247,075	7%	170,562	100%	62,847,215	100%

Table B-2. 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. Marion Co (rural)	43,387	16,042,238	5,262	2,605	2,169,985	13.5%	4,114	1,252	1,508,735	9.0%
Brooks	249	89,505	46	15	13,150	14.7%	33	6	7,740	9.0%
Butteville	193	78,691	40	15	13,144	16.7%	33	8	10,102	13.0%
Four Corners	6,508	1,801,596	466	92	86,298	4.8%	250	49	56,715	3.0%
Hayesville	7,876	2,382,452	777	176	158,025	6.6%	447	90	107,487	5.0%
Labish Village	167	43,407	15	3	3,211	7.4%	10	2	2,169	5.0%
Marion	244	64,728	3	0	876	1.4%	1	0	533	1.0%
Mehama	189	53,460	14	3	3,014	5.6%	6	1	1,485	3.0%
Total Unincorporated County	58,813	20,556,076	6,625	2,911	2,447,702	11.9%	4,893	1,408	1,694,966	8.0%
Aumsville	1,459	509,635	78	15	16,581	3.3%	25	2	8,869	2.0%
Aurora	560	258,763	76	24	31,709	12.3%	57	13	23,240	9.0%
Detroit	315	69,925	1	0	187	0.3%	1	0	134	0.0%
Donald	490	195,528	130	91	57,784	30.0%	118	33	32,604	17.0%
Gates	326	71,352	17	3	2,291	3.0%	7	1	1,305	2.0%
Gervais	719	247,297	151	115	55,401	22.0%	155	58	41,279	17.0%
Hubbard	1,187	458,199	279	186	125,814	27.0%	253	77	81,760	18.0%
Idanha	159	35,338	1	0	149	0.0%	1	0	104	0.0%
Jefferson	1,243	389,441	11	1	3,211	1.0%	4	0	1,869	0.0%
Keizer	16,380	5,592,798	3,017	977	722,048	13.0%	2,546	613	591,976	11.0%
Mill City	1,269	299,237	14	2	4,877	2.0%	7	1	3,577	1.0%
Mt. Angel	1,219	539,815	300	253	197,470	37.0%	273	135	123,614	23.0%
Salem	58,163	22,532,083	2,965	626	1,044,528	5.0%	1,600	309	595,384	3.0%

(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
Salem (West Salem)	10,797	3,194,904	456	124	132,316	4.0%	328	76	94,315	3.0%
Scotts Mills	242	63,043	53	65	16,983	27.0%	52	38	11,827	19.0%
Silverton	4,077	1,740,060	867	539	427,199	25.0%	754	303	282,972	16.0%
St. Paul	247	132,631	31	8	14,607	11.0%	22	5	9,671	7.0%
Stayton	3,043	1,546,547	126	23	64,343	4.0%	63	12	34,658	2.0%
Sublimity	1,157	546,449	18	2	7,851	1.0%	8	1	5,678	1.0%
Turner	1,365	421,185	47	8	11,886	3.0%	18	3	6,218	1.0%
Woodburn	7332	3,446,910	1764	1506	1,287,043	37.0%	1610	772	820,194	24.0%
Total Study Area	170,562	62,847,215	17,028	7,479	6,671,977	11.0%	12,796	3,860	4,466,215	7.0%

Table B-3. 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. Marion Co (rural)	43,387	16,042,238	97	1,650	0.0%	180	4,923	0.0%	247	9,060	0.1%	559	41,213	0.3%
Brooks	249	89,505	0	0	0.00%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Butteville	193	78,691	0	0	0.00%	0	0	0.00%	0	0	0.00%	31	2,646	3.36%
Four Corners	6,508	1,801,596	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Hayesville	7,876	2,382,452	0	0	0.0%	0	0	0.0%	0	0	0.0%	1	2	0.0%
Labish Village	167	43,407	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Marion	244	64,728	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Mehama	189	53,460	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Total Unincorp County	58,813	20,556,076	97	1,650	0.0%	180	4,923	0.0%	247	9,060	0.0%	591	43,861	0.2%
Aumsville	1,459	509,635	4	43	0.0%	6	63	0.0%	6	76	0.0%	6	94	0.0%
Aurora	560	258,763	0	0	0.0%	0	0	0.0%	2	7	0.00%	0	0	0.00%
Detroit	315	69,925	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Donald	490	195,528	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Gates	326	71,352	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Gervais	719	247,297	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Hubbard	1,187	458,199	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Idanha	159	35,338	1	7	0.0%	1	9	0.0%	2	23	0.1%	3	76	0.2%
Jefferson	1,243	389,441	0	0	0.0%	0	0	0.0%	2	8	0.0%	50	892	0.2%
Keizer	16,380	5,592,798	230	6,150	0.1%	320	21,726	0.4%	336	26,571	0.5%	4,908	408,198	7.3%
Mill City	1,269	299,237	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Mt. Angel	1,219	539,815	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Salem	58,163	22,532,083	489	20,961	0.1%	1,065	52,786	0.2%	1,431	70,473	0.3%	3,924	221,657	1.0%
Salem (West Salem)	10,797	3,194,904	3	6	0.0%	64	4,790	0.1%	157	12,098	0.4%	635	54,672	1.7%
Scotts Mills	242	63,043	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Silverton	4,077	1,740,060	0	0	0.0%	6	1,099	0.1%	12	1,861	0.1%	27	2,615	0.2%

			(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**
St. Paul	247	132,631	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Stayton	3,043	1,546,547	0	0	0.0%	2	10	0.0%	2	33	0.0%	5	153	0.0%
Sublimity	1,157	546,449	0	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Turner	1,365	421,185	93	928	0.2%	282	4,084	1.0%	347	5,849	1.4%	534	13,929	3.3%
Woodburn	7,332	3,446,910	0	0	0.0%	1	10	0.0%	8	266	0.0%	17	1,074	0.0%
Total Study Area	170,562	62,847,215	917	29,744	0.0%	1,927	89,501	0.1%	2,552	126,324	0.2%	10,700	747,221	1.2%

Table B-4. 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. Marion Co (rural)	43,387	47,599	205	0.4%	313	0.7%	66
Brooks	249	272	0	0.0%	0	0.0%	0
Butteville	193	352	0	0.0%	0	0.0%	0
Four Corners	6,508	9,385	0	0.0%	0	0.0%	0
Hayesville	7,876	11,677	0	0.0%	0	0.0%	0
Labish Village	167	232	0	0.0%	0	0.0%	0
Marion	244	230	0	0.0%	0	0.0%	0
Mehama	189	203	0	0.0%	0	0.0%	0
Total Unincorporated County	58,813	69,950	205	0.0%	313	1.0%	66
Aumsville	1,459	4,215	0	0.0%	6	0.0%	0
Aurora	560	985	0	0.0%	2	0.0%	0
Detroit	315	205	0	0.0%	0	0.0%	0
Donald	490	995	0	0.0%	0	0.0%	0
Gates	326	540	0	0.0%	0	0.0%	0
Gervais	719	2,620	0	0.0%	0	0.0%	0
Hubbard	1,187	3,315	0	0.0%	0	0.0%	0
Idanha	159	155	3	2.0%	3	2.0%	1
Jefferson	1,243	3,280	5	0.0%	3	0.0%	1
Keizer	16,380	38,585	704	2.0%	347	2.0%	11
Mill City	1,269	1,915	0	0.0%	0	0.0%	0
Mt. Angel	1,219	3,520	0	0.0%	0	0.0%	0
Salem	58,163	141,565	2,571	2.0%	1,726	3.0%	295

			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**
Salem (West Salem)	10,797	27,405	361	1.0%	174	2.0%	17
Scotts Mills	242	385	0	0.0%	0	0.0%	0
Silverton	4,077	10,520	81	1.0%	19	0.0%	7
St. Paul	247	440	0	0.0%	0	0.0%	0
Stayton	3,043	7,880	1	0.0%	2	0.0%	0
Sublimity	1,157	3,050	0	0.0%	0	0.0%	0
Turner	1,365	2,410	596	25.0%	448	33.0%	101
Woodburn	7332	25185	41	0.0%	10	0.0%	2
Total Study Area	170,562	349,120	4568	1.0%	3053	2.0%	501

Table B-5. Landslide exposure.

(all dollar amounts in thousands)

Community	Total Number of Buildings	Total Estimated Building Value ($)	Very High Susceptibility: Number of Buildings	Very High Susceptibility: Building Value ($)	Very High Susceptibility: Percent of Building Value Exposed	High Susceptibility: Number of Buildings	High Susceptibility: Building Value ($)	High Susceptibility: Percent of Building Value Exposed	Moderate Susceptibility: Number of Buildings	Moderate Susceptibility: Building Value ($)	Moderate Susceptibility: Percent of Building Value Exposed
Unincorp. Marion Co (rural)	43,387	16,042,238	2,019	676,155	4.2%	1,113	324,563	2.0%	8,651	2,680,246	17%
Brooks	249	89,505	0	0	0%	0	0	0%	17	3,460	4%
Butteville	193	78,691	6	1,851	2%	4	1,542	2.0%	58	22,666	29%
Four Corners	6,508	1,801,596	0	0	0%	2	78	0%	176	56,831	3%
Hayesville	7,876	2,382,452	0	0	0%	6	2,218	0.1%	235	68,187	3%
Labish Village	167	43,407	0	0	0%	0	0	0%	33	8,921	21%
Marion	244	64,728	0	0	0.0%	0	0	0%	1	89	0%
Mehama	189	53,460	19	7,351	14%	10	1,962	3.7%	21	5,100	10%
Total Unincorp. County	58,813	20,556,076	2,044	685,357	3.3%	1,135	330,362	1.6%	9,192	2,845,499	14%
Aumsville	1,459	509,635	0	0	0%	0	0	0%	26	7,372	1%
Aurora	560	258,763	0	0	0%	15	5,511	2.1%	192	81,235	31%
Detroit	315	69,925	54	10,546	15%	24	7,485	10.7%	134	28,616	41%
Donald	490	195,528	0	0	0%	0	0	0%	1	314	0%
Gates	326	71,352	141	26,006	36%	10	2,391	3.4%	20	5,402	7.6%
Gervais	719	247,297	0	0	0%	0	0	0%	2	748	0.3%
Hubbard	1,187	458,199	0	0	0%	2	594	0.1%	53	17,912	3.9%
Idanha	159	35,338	20	3,092	8.8%	19	6,843	19%	60	11,972	34%
Jefferson	1,243	389,441	0	0	0%	0	0	0%	56	15,970	4.1%
Keizer	16,380	5,592,798	0	0	0%	62	18,852	0.3%	1,107	396,935	7.1%
Mill City	1,269	299,237	45	12,464	4.2%	33	6,576	2.2%	155	34,342	12%
Mt. Angel	1,219	539,815	0	0	0%	0	0	0%	108	50,742	9.4%
Salem	58,163	22,532,083	1,531	633,172	2.8%	1,396	627,843	2.8%	8,647	3,333,449	15%

			(all dollar amounts in thousands)								
			Very High Susceptibility			**High Susceptibility**			**Moderate Susceptibility**		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**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**
Salem (West Salem)	10,797	3,194,904	0	0	0%	424	117,055	3.7%	4,759	1,455,158	46%
Scotts Mills	242	63,043	132	28,843	46%	8	2,471	3.9%	12	3,784	6.0%
Silverton	4,077	1,740,060	115	47,778	2.7%	73	32,583	1.9%	737	305,763	18%
St. Paul	247	132,631	0	0	0%	1	220	0.2%	27	8,898	6.7%
Stayton	3,043	1,546,547	9	4,227	0.3%	23	9,063	0.6%	338	159,959	10%
Sublimity	1,157	546,449	0	0	0%	0	0	0%	92	45,157	8.3%
Turner	1,365	421,185	113	33,157	7.9%	36	9,329	2.2%	199	66,040	16%
Woodburn	7,332	3,446,910	0	0	0%	5	1,224	0%	312	104,945	4.2%
Total Study Area	170,562	62,847,215	4,204	1,484,643	2.4%	3,266	1,178,402	1.9%	26,229	8,980,211	14%

Table B-6. Channel migration zone exposure.

				(all dollar amounts in thousands)				
				Channel Migration Hazard				
Community	**Total Number of Buildings**	**Total Population**	**Total Estimated Building Value ($)**	**Potentially Displaced Residents From Channel Migration Exposure**	**% Potentially Displaced Residents From Channel Migration Exposure**	**Number of Buildings Exposed**	**Building Value ($)**	**Ratio of Exposure Value**
Unincorp. Marion Co (rural)	43,387	47,599	16,042,238	263	0.6%	288	90,300	0.6%
Brooks	249	272	89,505	0	0.0%	0	0	0.0%
Butteville	193	352	78,691	0	0.0%	0	0	0.0%
Four Corners	6,508	9,385	1,801,596	0	0.0%	0	0	0.0%
Hayesville	7,876	11,677	2,382,452	0	0.0%	0	0	0.0%
Labish Village	167	232	43,407	0	0.0%	0	0	0.0%
Marion	244	230	64,728	0	0.0%	0	0	0.0%
Mehama	189	203	53,460	8	3.9%	12	3,051	5.7%
Total Unincorporated	58,813	69,950	20,556,076	271	0.4%	300	93,351	0.5%
Aumsville	1,459	4,215	509,635	0	0.0%	0	0	0.0%
Aurora	560	985	258,763	0	0.0%	1	118	0.1%
Detroit	315	205	69,925	0	0.0%	0	0	0.0%
Donald	490	995	195,528	0	0.0%	0	0	0.0%
Gates	326	540	71,352	53	10.0%	27	7,145	10.0%
Gervais	719	2,620	247,297	0	0.0%	0	0	0.0%
Hubbard	1,187	3,315	458,199	0	0.0%	0	0	0.0%
Idanha	159	155	35,338	23	15.0%	21	4,094	15.0%
Jefferson	1,243	3,280	389,441	62	1.9%	25	8,146	2.1%
Keizer	16,380	38,585	5,592,798	0	0.0%	0	0	0.0%
Mill City	1,269	1,915	299,237	196	10.0%	72	25,451	8.5%
Mt. Angel	1,219	3,520	539,815	0	0.0%	0	0	0.0%
Salem	58,163	141,565	22,532,083	0	0.0%	0	0	0.0%

				(all dollar amounts in thousands)				
				Channel Migration Hazard				
Community	**Total Number of Buildings**	**Total Population**	**Total Estimated Building Value ($)**	**Potentially Displaced Residents From Channel Migration Exposure**	**% Potentially Displaced Residents From Channel Migration Exposure**	**Number of Buildings Exposed**	**Building Value ($)**	**Ratio of Exposure Value**
Salem (West Salem)	10,797	27,405	3,194,904	4	0.0%	1	428	0.0%
Scotts Mills	242	385	63,043	0	0.0%	0	0	0.0%
Silverton	4,077	10,520	1,740,060	0	0.0%	0	0	0.0%
St. Paul	247	440	132,631	0	0.0%	0	0	0.0%
Stayton	3,043	7,880	1,546,547	866	11.0%	379	157,134	10.0%
Sublimity	1,157	3,050	546,449	0	0.0%	0	0	0.0%
Turner	1,365	2,410	421,185	0	0.0%	0	0	0.0%
Woodburn	7,332	25,185	3,446,910	0	0.0%	0	0	0.0%
Total Study Area	170,562	349,120	62,847,215	1,475	0.4%	826	295,868	0.5%

Table B-7. Wildfire exposure.

(all dollar amounts in thousands)

			High Hazard			Moderate Hazard		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**
Unincorp. Marion Co (rural)	43,387	16,042,238	154	38,350	0.0%	1,396	378,590	2.0%
Brooks	249	89,505	0	0	0.0%	0	0	0.0%
Butteville	193	78,691	0	0	0.0%	0	0	0.0%
Four Corners	6,508	1,801,596	0	0	0.0%	0	0	0.0%
Hayesville	7,876	2,382,452	0	0	0.0%	7	1,209	0.0%
Labish Village	167	43,407	0	0	0.0%	0	0	0.0%
Marion	244	64,728	0	0	0.0%	1	408	1.0%
Mehama	189	53,460	9	1,787	3.3%	19	5,288	10.0%
Total Unincorp. County	58,813	20,556,076	163	40,137	0.0%	1,423	385,496	1.9%
Aumsville	1,459	509,635	0	0	0.0%	46	19,823	4.0%
Aurora	560	258,763	0	0	0.0%	14	8,339	3.0%
Detroit	315	69,925	111	23,075	33.0%	74	13,841	20.0%
Donald	490	195,528	0	0	0.0%	0	0	0.0%
Gates	326	71,352	52	12,128	17.0%	72	14,997	21.0%
Gervais	719	247,297	0	0	0.0%	0	0	0.0%
Hubbard	1,187	458,199	0	0	0.0%	0	0	0.0%
Idanha	159	35,338	62	13,003	36.8%	4	607	1.7%
Jefferson	1,243	389,441	0	0	0.0%	4	1,626	0.4%
Keizer	16,380	5,592,798	0	0	0.0%	6	2,191	0.0%
Mill City	1,269	299,237	13	3,993	1.3%	158	34,753	11.6%
Mt. Angel	1,219	539,815	0	0	0.0%	2	173	0.0%
Salem	58,163	22,532,083	67	26,292	0.1%	365	143,743	0.6%
Salem (West Salem)	10,797	3,194,904	0	0	0.0%	0	0	0.0%

(all dollar amounts in thousands)

			High Hazard			Moderate Hazard		
Community	**Total Number of Buildings**	**Total Estimated Building Value ($)**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**	**Number of Buildings**	**Building Value ($)**	**Percent of Building Value Exposed**
Scotts Mills	242	63,043	0	0	0.0%	7	1,280	2.0%
Silverton	4,077	1,740,060	11	3,764	0.2%	95	40,887	2.3%
St. Paul	247	132,631	0	0	0.0%	0	0	0.0%
Stayton	3,043	1,546,547	0	0	0.0%	22	9,114	0.6%
Sublimity	1,157	546,449	0	0	0.0%	0	0	0.0%
Turner	1,365	421,185	0	0	0.0%	28	6,515	1.5%
Woodburn	7332	3,446,910	0	0	0.0%	20	8,217	0.2%
Total Study Area	170,562	62,847,215	479	122,391	0.2%	2,340	691,602	1.1%

Table B-8. Volcanic lahar - lahar exposure.

Community	Total Number of Buildings	Total Estimated Building Value ($)	Small: 1%-0.1% (100 to 1,000-yr)			Medium: 0.1%-0.007% (1,000 to 15,000-yr)			Large: >0.007% (>15,000-yr)		
			Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio	Number of Buildings	Loss Estimate	Loss Ratio
Unincorp. Marion Co (rural)	43,387	16,042,238	73	13,604	0.1%	175	43,913	0.30%	1,107	344,288	2.0%
Brooks	249	89,505	0	0	0.0%	0	0	0.00%	0	0	0.0%
Butteville	193	78,691	0	0	0.0%	0	0	0.00%	0	0	0.0%
Four Corners	6,508	1,801,596	0	0	0.0%	0	0	0.00%	0	0	0.0%
Hayesville	7,876	2,382,452	0	0	0.0%	0	0	0.00%	0	0	0.0%
Labish Village	167	43,407	0	0	0.0%	0	0	0.00%	0	0	0.0%
Marion	244	64,728	0	0	0.0%	0	0	0.00%	0	0	0.0%
Mehama	189	53,460	0	0	0.0%	0	0	0.00%	156	44,399	83.0%
Total Unincorp. County	58,813	20,556,076	73	13,604	0.1%	175	43,913	0.20%	1,263	388,686	1.9%
Aumsville	1,459	509,635	0	0	0.0%	0	0	0.00%	0	0	0.0%
Aurora	560	258,763	0	0	0.0%	0	0	0.00%	0	0	0.0%
Detroit	315	69,925	131	32,835	47.0%	198	47,132	67%	260	59,862	86.0%
Donald	490	195,528	0	0	0.0%	0	0	0.00%	0	0	0.0%
Gates	326	71,352	0	0	0.0%	216	49,569	70%	280	62,651	88.0%
Gervais	719	247,297	0	0	0.0%	0	0	0.00%	0	0	0.0%
Hubbard	1,187	458,199	0	0	0.0%	0	0	0.00%	0	0	0.0%
Idanha	159	35,338	108	23,151	66.0%	127	27,525	78%	151	33,496	95.0%
Jefferson	1,243	389,441	0	0	0.0%	0	0	0.00%	0	0	0.0%
Keizer	16,380	5,592,798	0	0	0.0%	0	0	0.00%	0	0	0.0%
Mill City	1,269	299,237	0	0	0.0%	1,069	245,855	82%	1,103	255,078	85.0%
Mt. Angel	1,219	539,815	0	0	0.0%	0	0	0.00%	0	0	0.0%
Salem	58,163	22,532,083	0	0	0.0%	0	0	0.00%	0	0	0.0%
Salem (West Salem)	10,797	3,194,904	0	0	0.0%	4	772	0.00%	4	772	0.0%

			Small: 1%-0.1% (100 to 1,000-yr)			Medium: 0.1%-0.007% (1,000 to 15,000-yr)			Large: >0.007% (>15,000-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**
Scotts Mills	242	63,043	0	0	0.0%	0	0	0.00%	0	0	0.0%
Silverton	4,077	1,740,060	0	0	0.0%	0	0	0.00%	0	0	0.0%
St. Paul	247	132,631	0	0	0.0%	0	0	0.00%	0	0	0.0%
Stayton	3,043	1,546,547	0	0	0.0%	0	0	0.00%	2,228	1,184,906	77.0%
Sublimity	1,157	546,449	0	0	0.0%	0	0	0.00%	0	0	0.0%
Turner	1,365	421,185	0	0	0.0%	0	0	0.00%	0	0	0.0%
Woodburn	7,332	3,446,910	0	0	0.0%	0	0	0.00%	0	0	0.0%
Total Study Area	170,562	62,847,215	312	69,591	0.1%	1,789	414,766	0.70%	5,289	1,985,452	3.2%

APPENDIX C. HAZUS-MH METHODOLOGY

C.1 Software

We performed all loss estimations using Hazus®-MH 4.2 and ArcGIS® Desktop® 10.2.2.

C.2 User-Defined Facilities (UDF) Database

A UDF database was compiled for all buildings in Marion County for use in both the flood and earthquake modules of Hazus-MH. The Marion County assessor database (acquired in 2021) was used to determine which taxlots had improvements (i.e., buildings) and how many building points should be included in the UDF database.

C.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.

C.2.2 Attributing building points

Populating the required attributes for Hazus-MH was achieved through a variety of approaches. The Marion 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-MH 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 Marion 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 Marion 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 Marion 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 Marion 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-MH Technical Manual for the Flood Model [FEMA Hazus-MH, 2012a]). 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 Marion 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-MH, where Hazus-MH 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-MH for estimating earthquake losses by determining which damage function will be applied. This information was unavailable from the Marion 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-MH for estimating earthquake losses by determining which damage function will be applied. This information is derived from the **Year Built** attribute (Marion 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, 2010a) 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.

C.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-MH earthquake model to determine what damage functions are applied to a given building (FEMA, 2012b). 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 Marion County. **Table C-1** outlines the benchmark years that apply to buildings within Marion County.

Table C-1. Marion County seismic design level benchmark years.

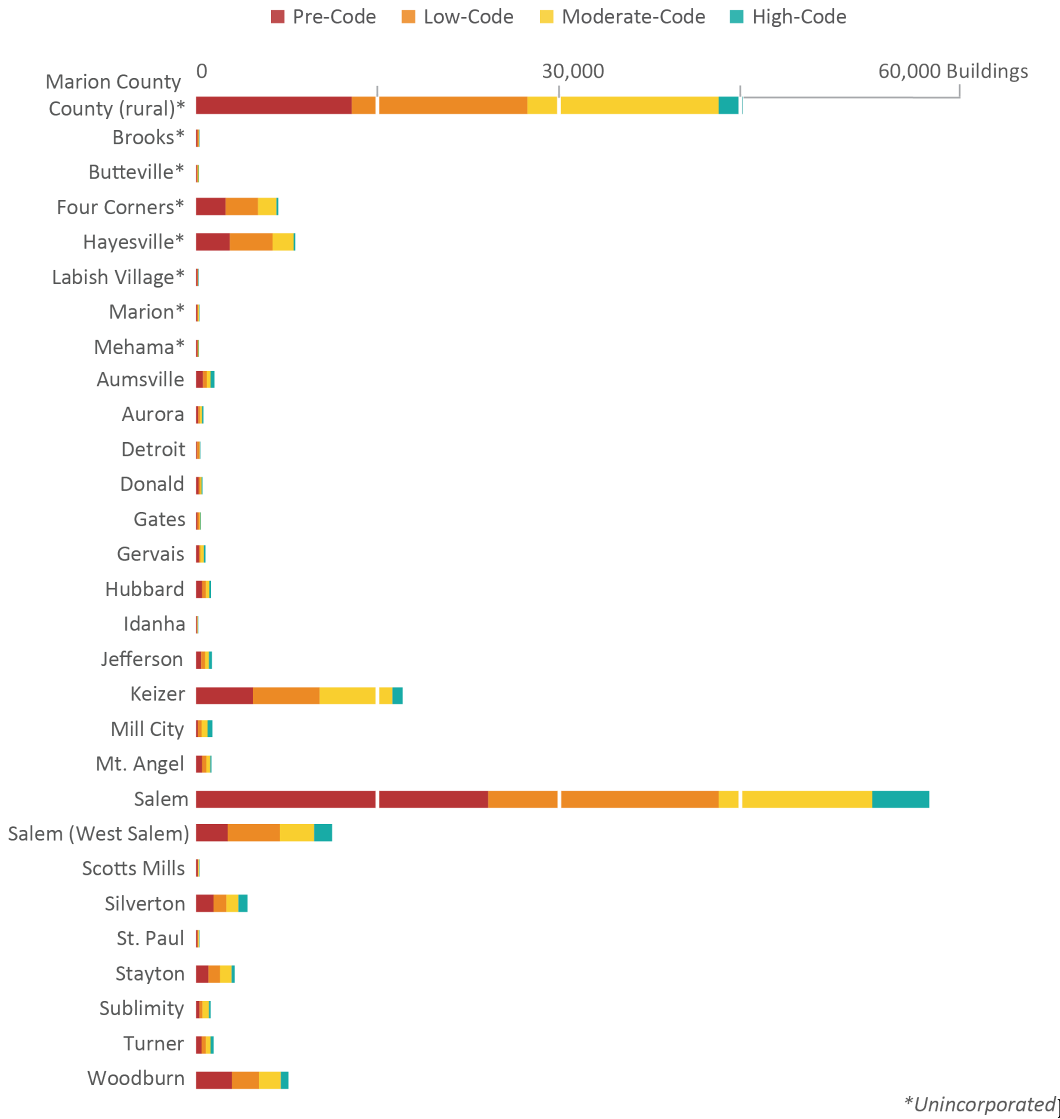
Building Type	Year Built	Design Level	Basis
Single-Family Dwelling (includes Duplexes)	prior to 1976	Pre Code	Interpretation of Judson (Judson, 2012)
	1976–1991	Low Code	
	1992–2003	Moderate Code	
	2004–2016	High Code	
Manufactured Housing	prior to 2003	Pre Code	Interpretation of OR BCD 2002 Manufactured 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 2014-0311 Oregon Benefit-Cost Analysis Tool, p. 24 (Business Oregon, 2015)
	1976–1990	Low Code	
	1991–2016	Moderate Code	

Table C-2 and corresponding **Figure C-1** illustrate the current state of seismic building codes for the county.

Table C-2. Seismic design level in Marion 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. Marion Co (rural)	43,387	12,333	28%	13,978	32%	15,162	35%	1,914	4.4%
Brooks	249	100	40%	76	30.5%	56	22.5%	17	6.8%
Butteville	193	54	28%	56	29%	70	36%	13	6.7%
Four Corners	6,508	2,338	36%	2,575	40%	1,472	23%	123	1.9%
Hayesville	7,876	2,661	34%	3,393	43.1%	1,660	21.1%	162	2.1%
Labish Village	167	84	50%	58	35%	18	11%	7	4.2%
Marion	244	95	39%	45	18.4%	82	33.6%	22	9.0%
Mehama	189	81	43%	65	34%	33	17%	10	5.3%
Total Unincorporated County	58,813	17,746	30%	20,246	34%	18,553	32%	2,268	3.9%
Aumsville	1,459	526	36%	312	21.4%	316	22%	305	21%
Aurora	560	161	29%	126	22.5%	161	28.8%	112	20.0%
Detroit	315	55	17%	217	68.9%	24	7.6%	19	6.0%
Donald	490	199	41%	118	24.1%	119	24%	54	11.0%
Gates	326	101	31%	149	46%	60	18%	16	5%
Gervais	719	219	30%	109	15%	260	36%	131	18%
Hubbard	1,187	462	39%	303	26%	277	23%	145	12%
Idanha	159	55	35%	48	30%	37	23%	19	12%
Jefferson	1,243	390	31%	307	25%	296	24%	250	20%
Keizer	16,380	4,513	28%	5,268	32%	5,773	35%	826	5%
Mill City	1,269	110	9%	328	26%	466	37%	365	29%
Mt. Angel	1,219	453	37%	334	27%	314	26%	118	10%
Salem	58,163	23,168	40%	18,285	31%	12,217	21%	4,493	8%
Salem (West Salem)	10,797	2,498	23%	4,129	38%	2,735	25%	1,435	13%
Scotts Mills	242	116	48%	43	18%	61	25%	22	9%
Silverton	4,077	1,395	34%	997	24%	964	24%	721	18%
St. Paul	247	78	32%	68	28%	89	36%	12	5%
Stayton	3,043	980	32%	903	30%	933	31%	227	7%
Sublimity	1,157	254	22%	256	22%	488	42%	159	14%
Turner	1,365	432	32%	340	25%	369	27%	224	16%
Woodburn	7,332	2,850	39%	2,135	29%	1,730	24%	617	8%
Total Study Area	170,562	56,761	33%	55,021	32%	46,242	27%	12,538	7%

Figure C-1. Seismic design level by Marion County community.



C.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 Marion County FIRMs (FEMA, 2018). 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-MH 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-MH 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.

C.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-MH 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-MH 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.

C.5 Post-Analysis Quality Control

Ensuring the quality of the results from Hazus-MH 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-MH 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 D. ACRONYMS AND DEFINITIONS

D.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

D.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-MH, 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-MH – 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.

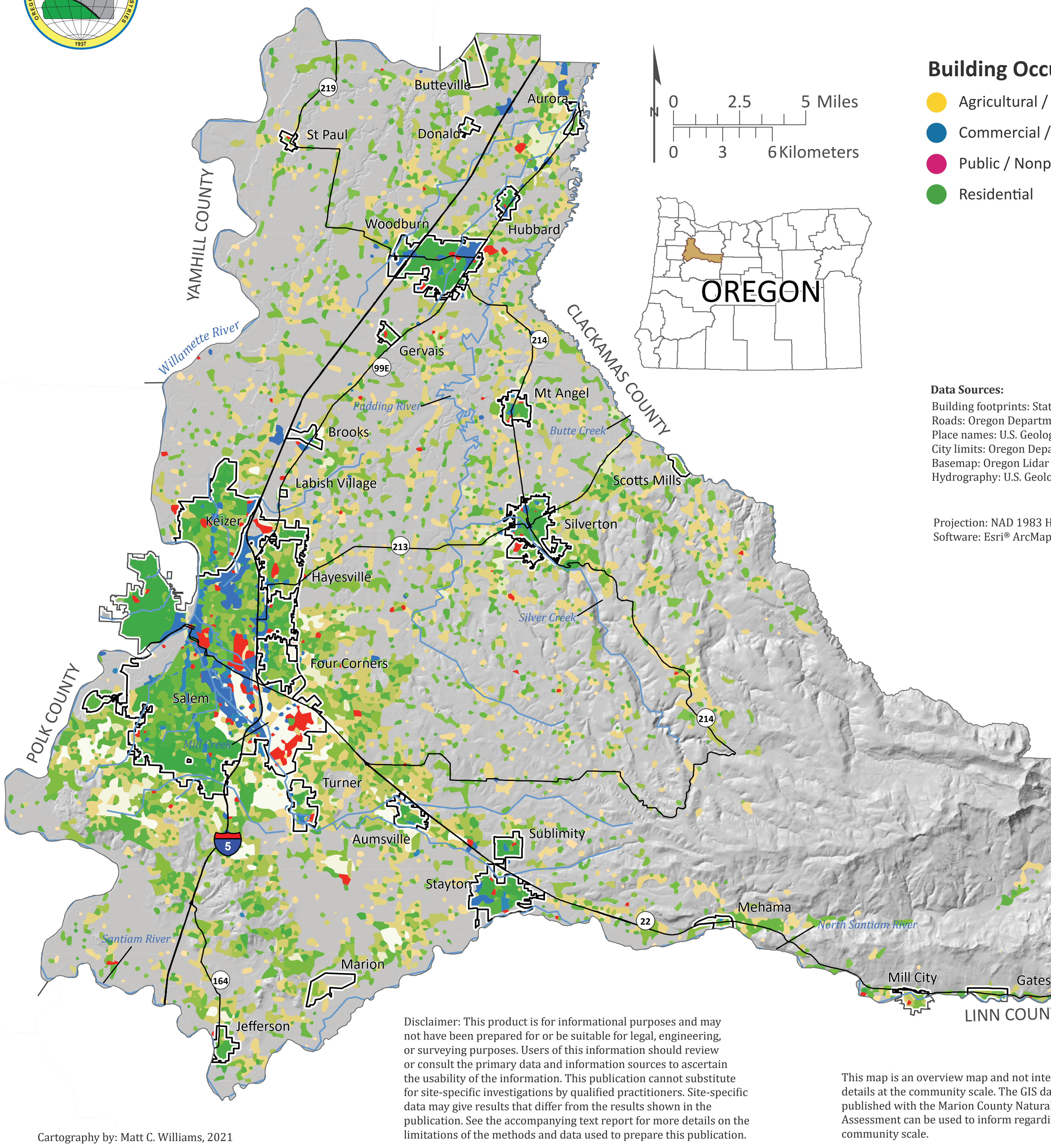
Vulnerability – Characteristics that make people or assets more susceptible to a natural hazard.

APPENDIX E. MAP PLATES

See appendix folder for individual map PDFs.

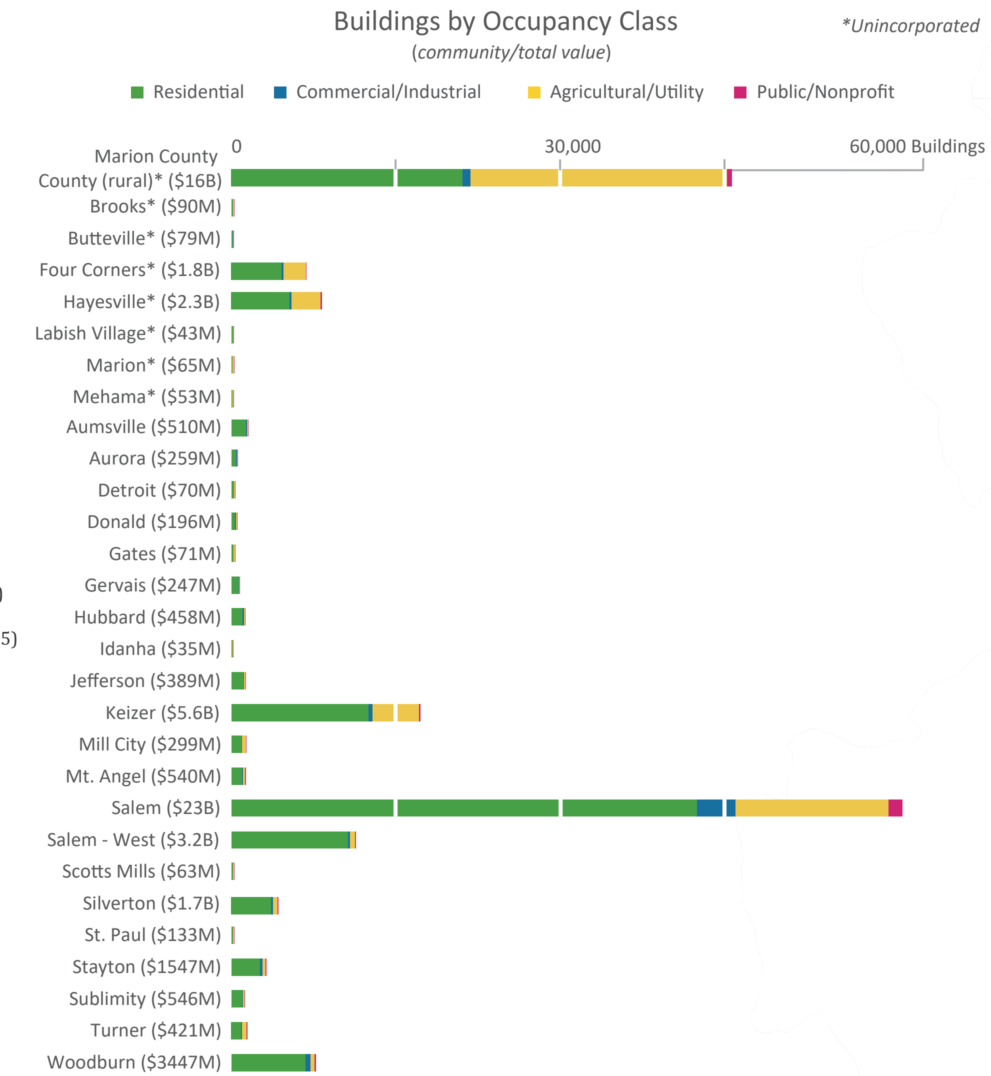
Building Distribution Map of Marion County, Oregon

PLATE 1



Building Occupancy

- Agricultural / Utility
- Commercial / Industrial
- Public / Nonprofit
- Residential



Data Sources:
Building footprints: Statewide Building Footprints for Oregon, release 1.0 (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 (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

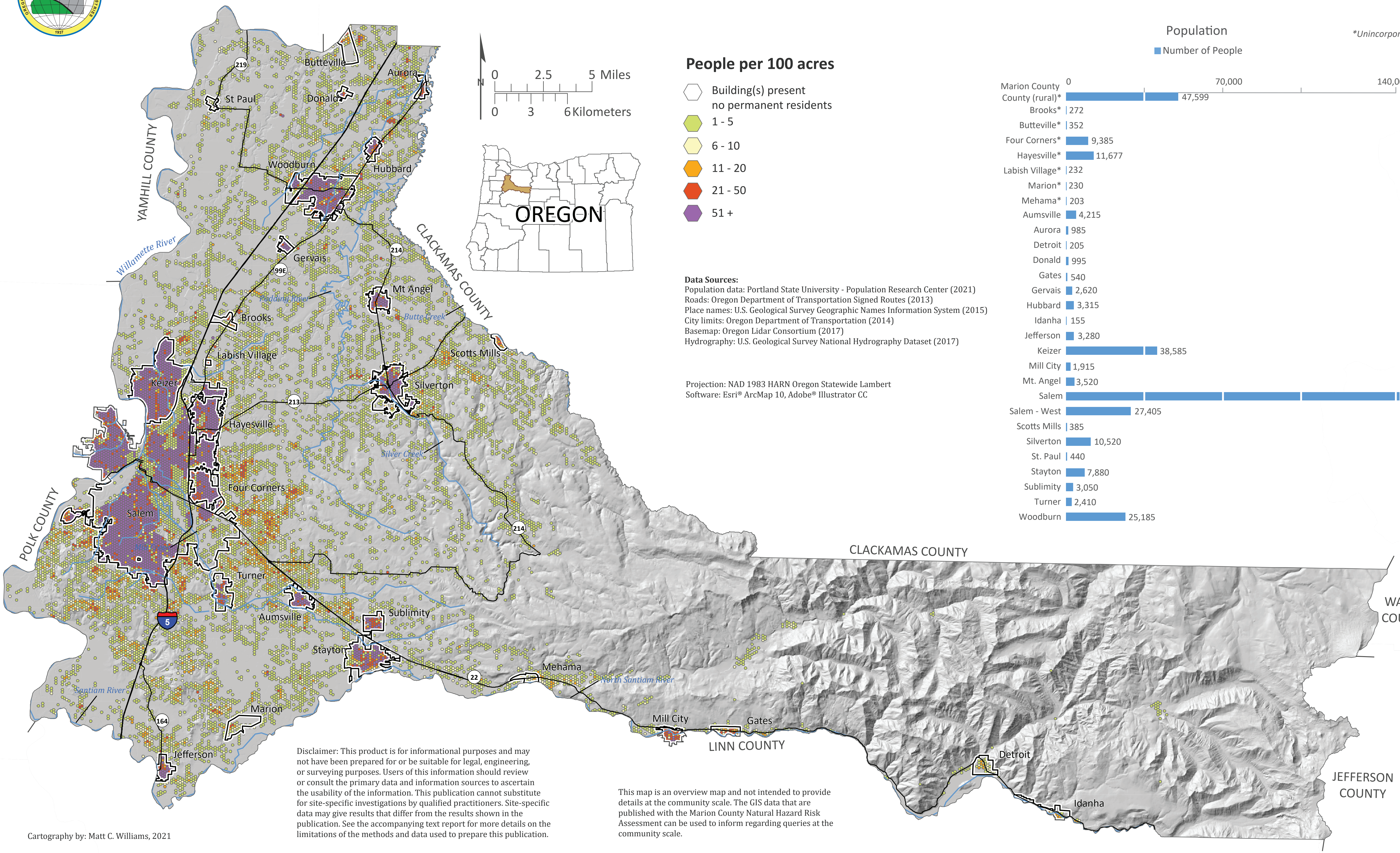
Disclaimer: This product is for informational purposes and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information. This publication 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.

This map is an overview map and not intended to provide details at the community scale. The GIS data that are published with the Marion County Natural Hazard Risk Assessment can be used to inform regarding queries at the community scale.

Cartography by: Matt C. Williams, 2021

Population Density Map of Marion County, Oregon

PLATE 2



Data Sources:
Population data: Portland State University - Population Research Center (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 (2017)
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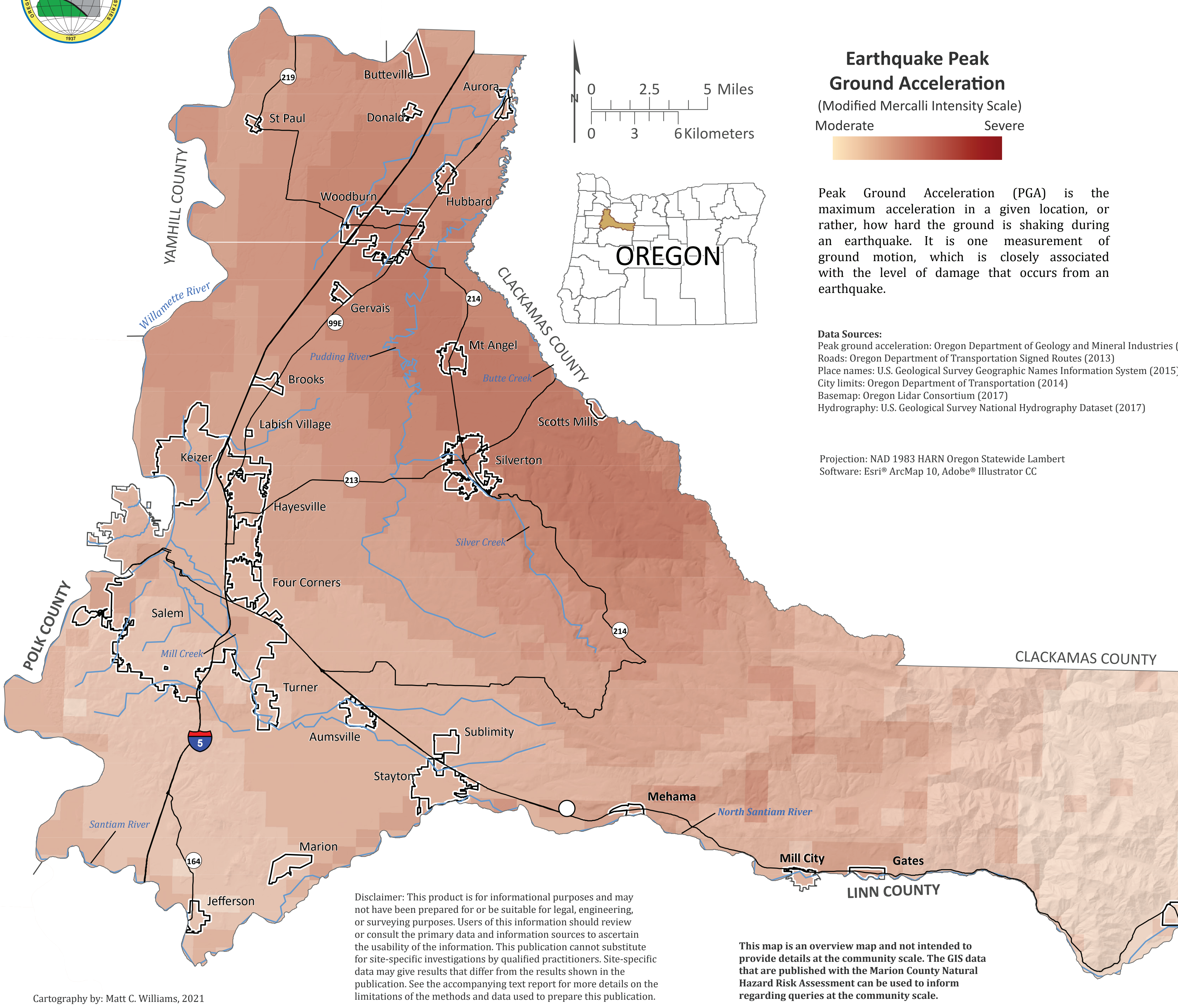
Cartography by: Matt C. Williams, 2021

Mt. Angel Fault Magnitude-6.8 Earthquake Shaking Map of Marion County, Oregon

PLATE 3



Earthquake Peak Ground Acceleration

(Modified Mercalli Intensity Scale)

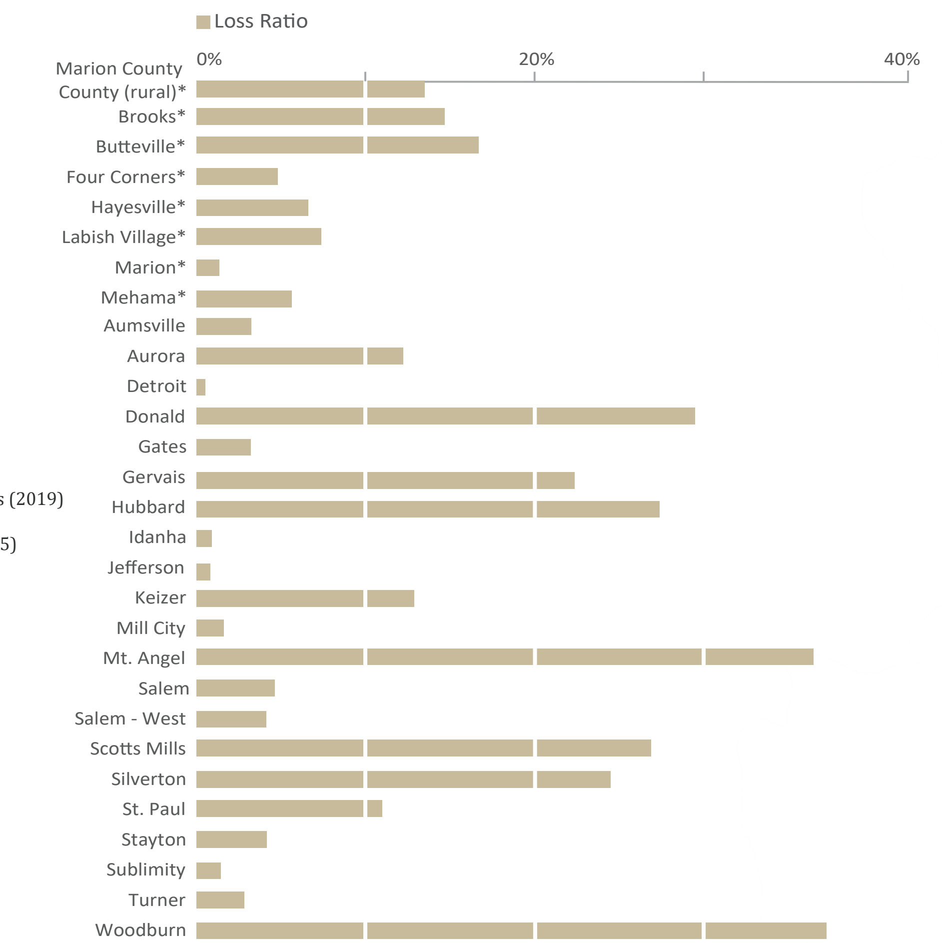
Moderate — Severe

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.

Data Sources:
Peak ground acceleration: Oregon Department of Geology and Mineral Industries (2019)
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 (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Total Building Value Loss Ratio from Mt. Angel Fault - Mw-6.8



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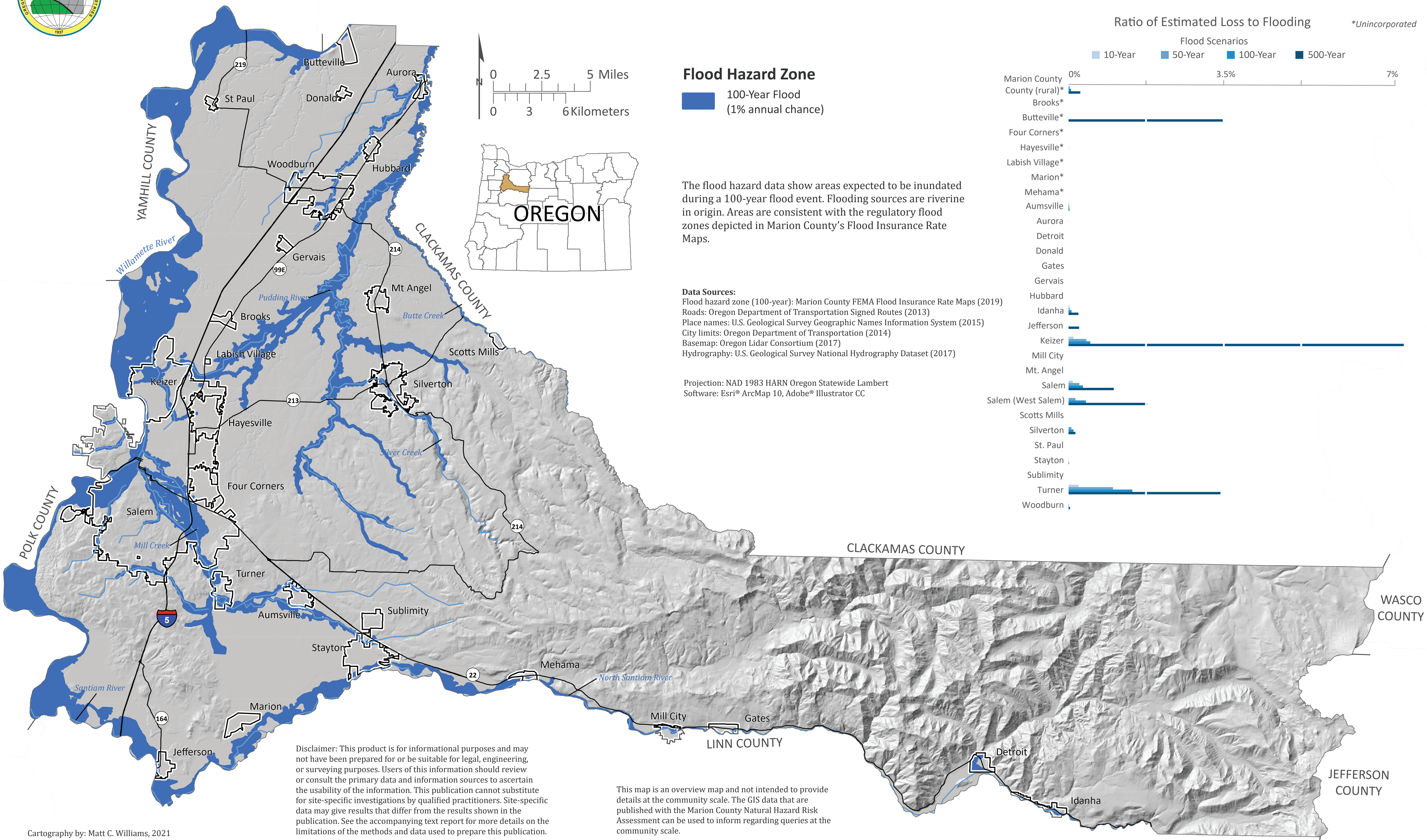
Cartography by: Matt C. Williams, 2021

Flood Hazard Map of Marion County, Oregon



Flood Hazard Zone

100-Year Flood (1% annual chance)

The flood hazard data show areas expected to be inundated during a 100-year flood event. Flooding sources are riverine in origin. Areas are consistent with the regulatory flood zones depicted in Marion County's Flood Insurance Rate Maps.

Data Sources:
Flood hazard zone (100-year): Marion County FEMA Flood Insurance Rate Maps (2019)
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 (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
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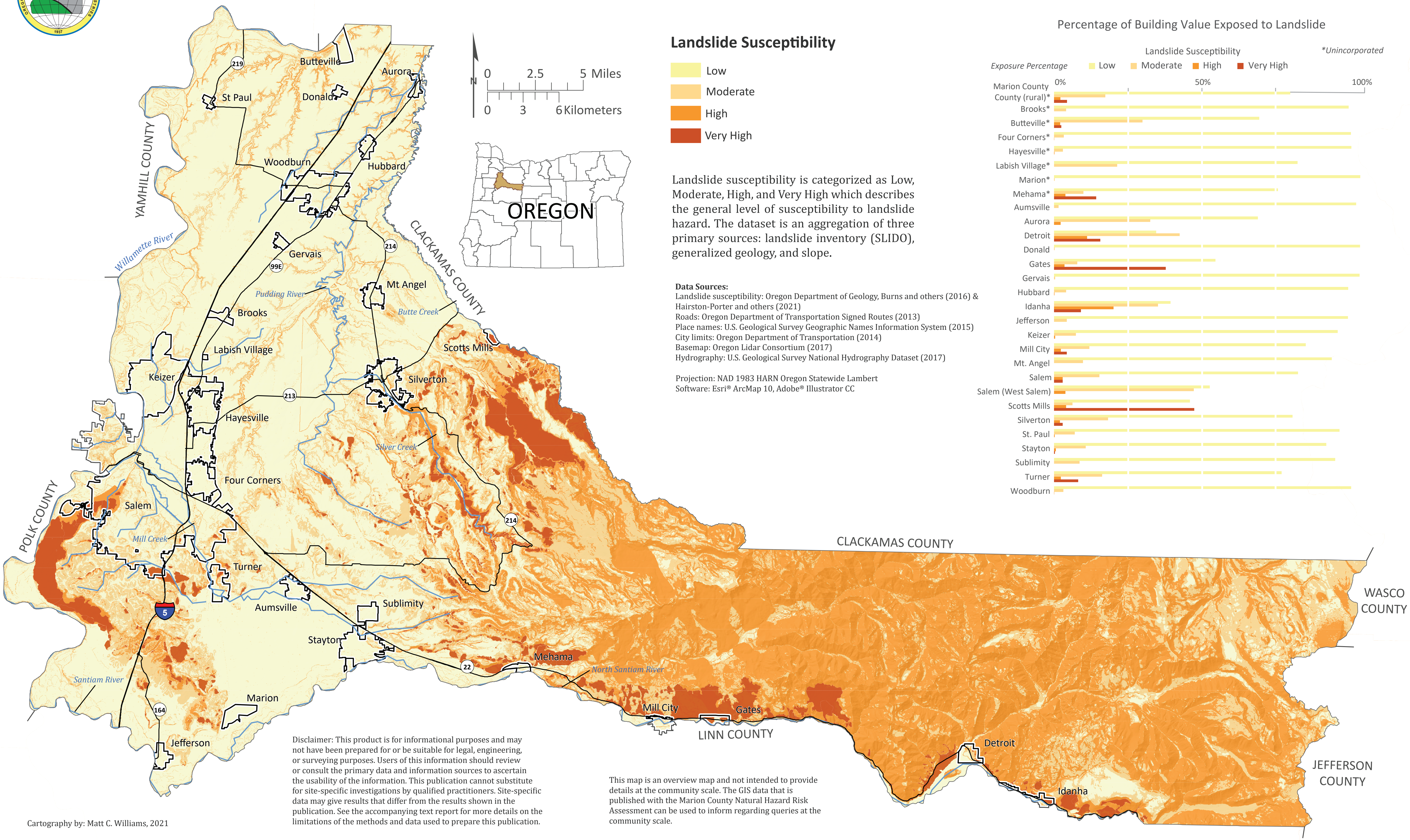
Cartography by: Matt C. Williams, 2021

Landslide Susceptibility Map of Marion County, Oregon



Landslide Susceptibility

- Low
- Moderate
- High
- Very High

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, Burns and others (2016) & Hairston-Porter 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 (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
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Percentage of Building Value Exposed to Landslide

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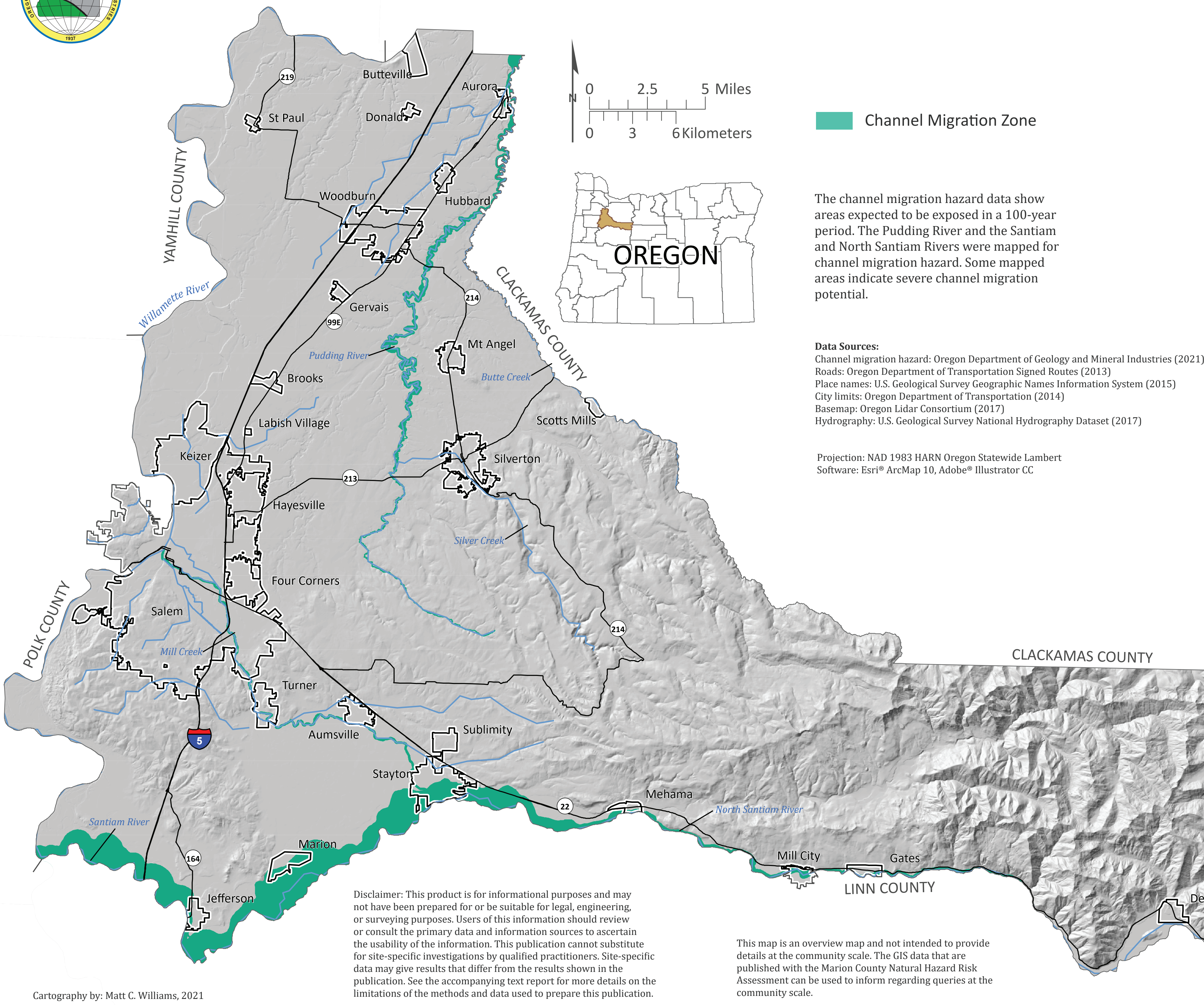
Cartography by: Matt C. Williams, 2021

Channel Migration Zone Map of Marion County, Oregon

PLATE 6

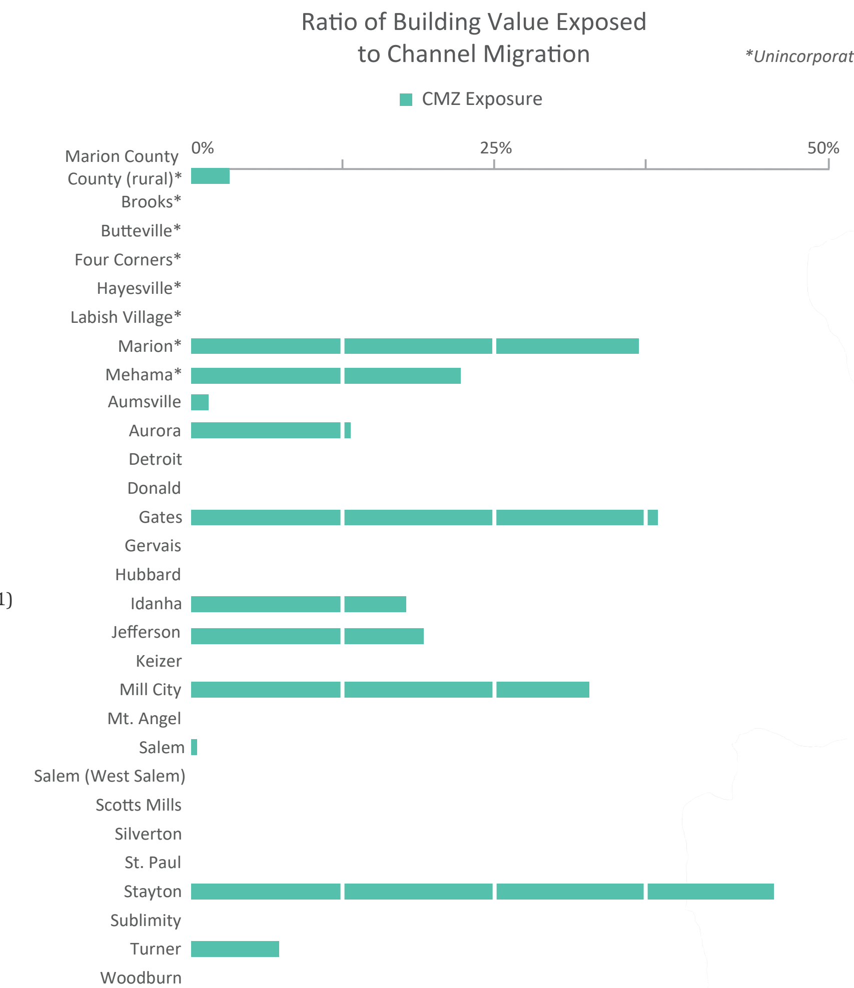


Channel Migration Zone

The channel migration hazard data show areas expected to be exposed in a 100-year period. The Pudding River and the Santiam and North Santiam Rivers were mapped for channel migration hazard. Some mapped areas indicate severe channel migration potential.

Data Sources:
Channel migration hazard: Oregon Department of Geology and Mineral Industries (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 (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC



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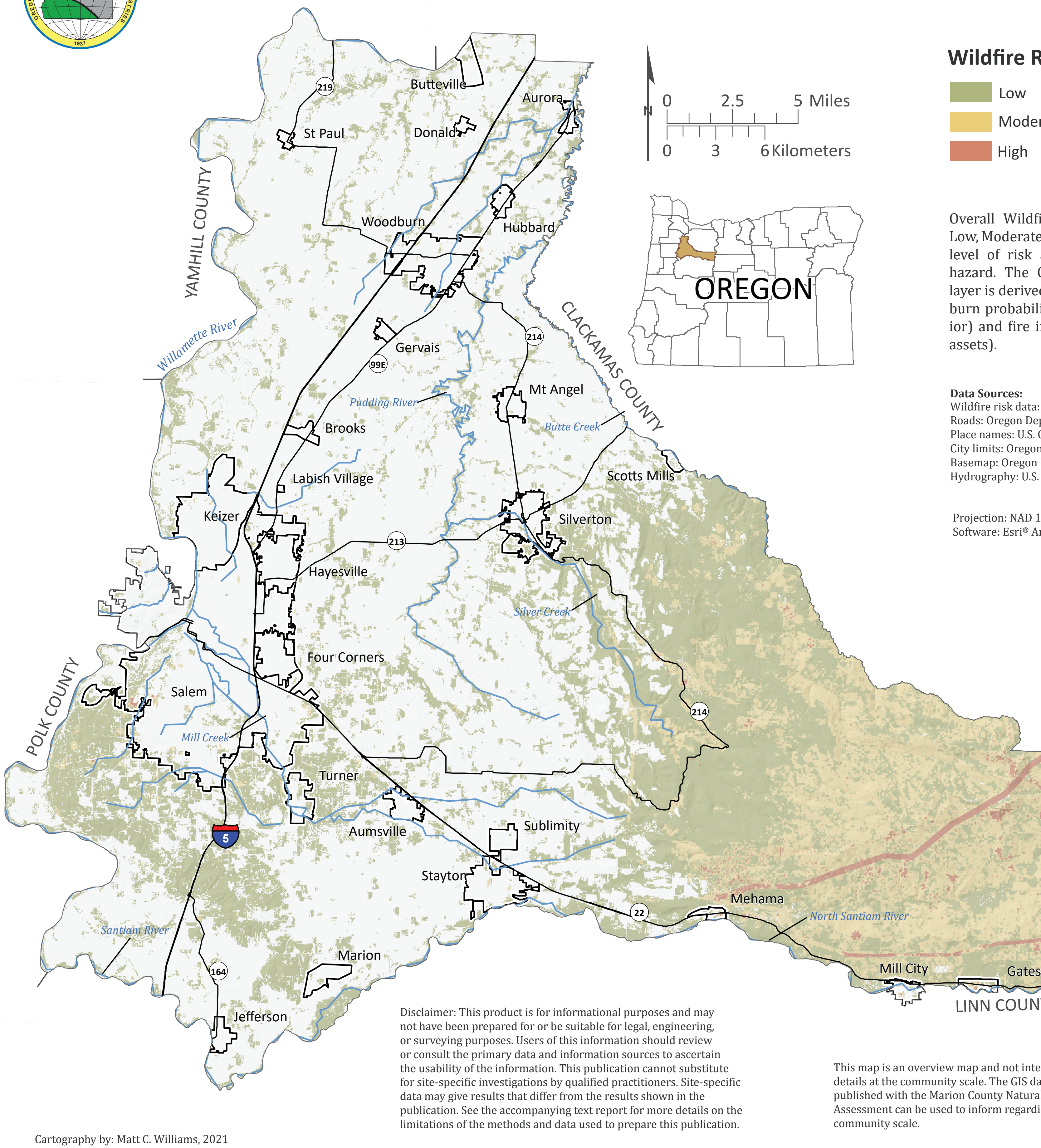
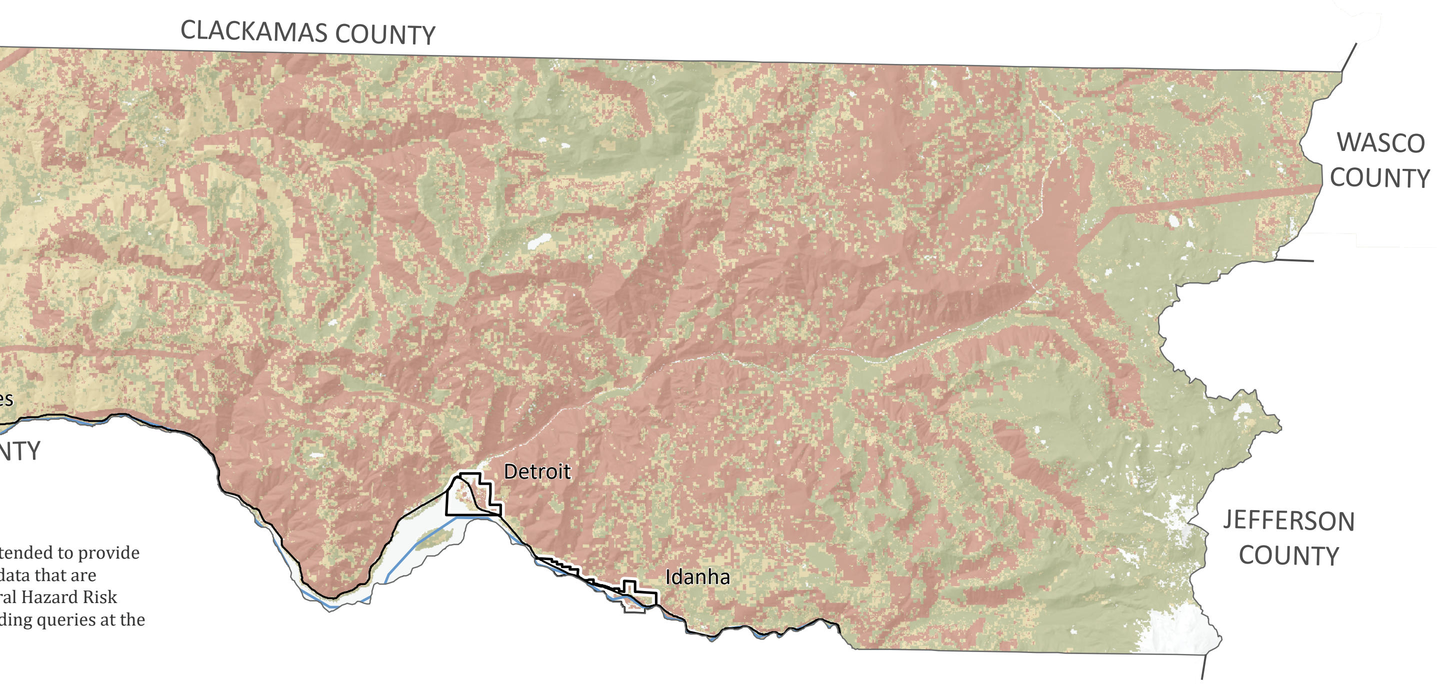
Cartography by: Matt C. Williams, 2021

Wildfire Risk Map of Marion County, Oregon

PLATE 7





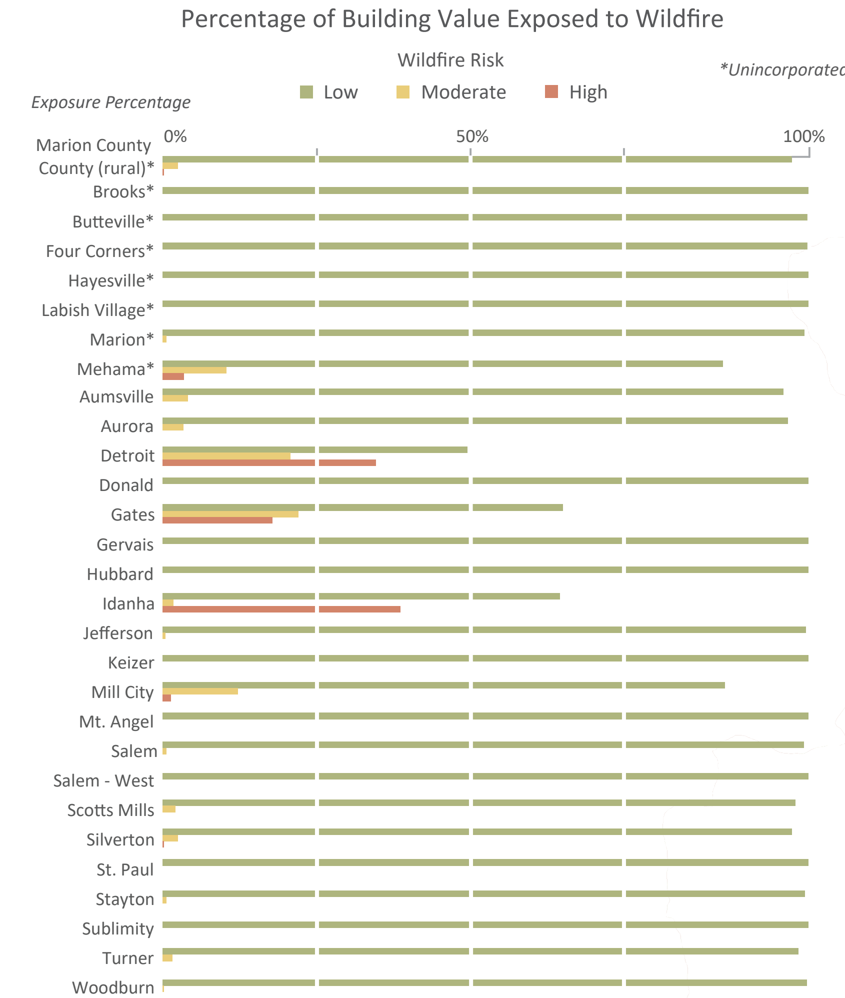
Wildfire Risk

- Low
- Moderate
- High

Overall Wildfire Risk is categorized as Low, Moderate, and High and indicates the level of risk a location has to wildfire hazard. The Overall Wildfire Risk data layer is derived from a combination of the burn probability (fire history and behavior) and fire impacts (infrastructure and assets).

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 (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC



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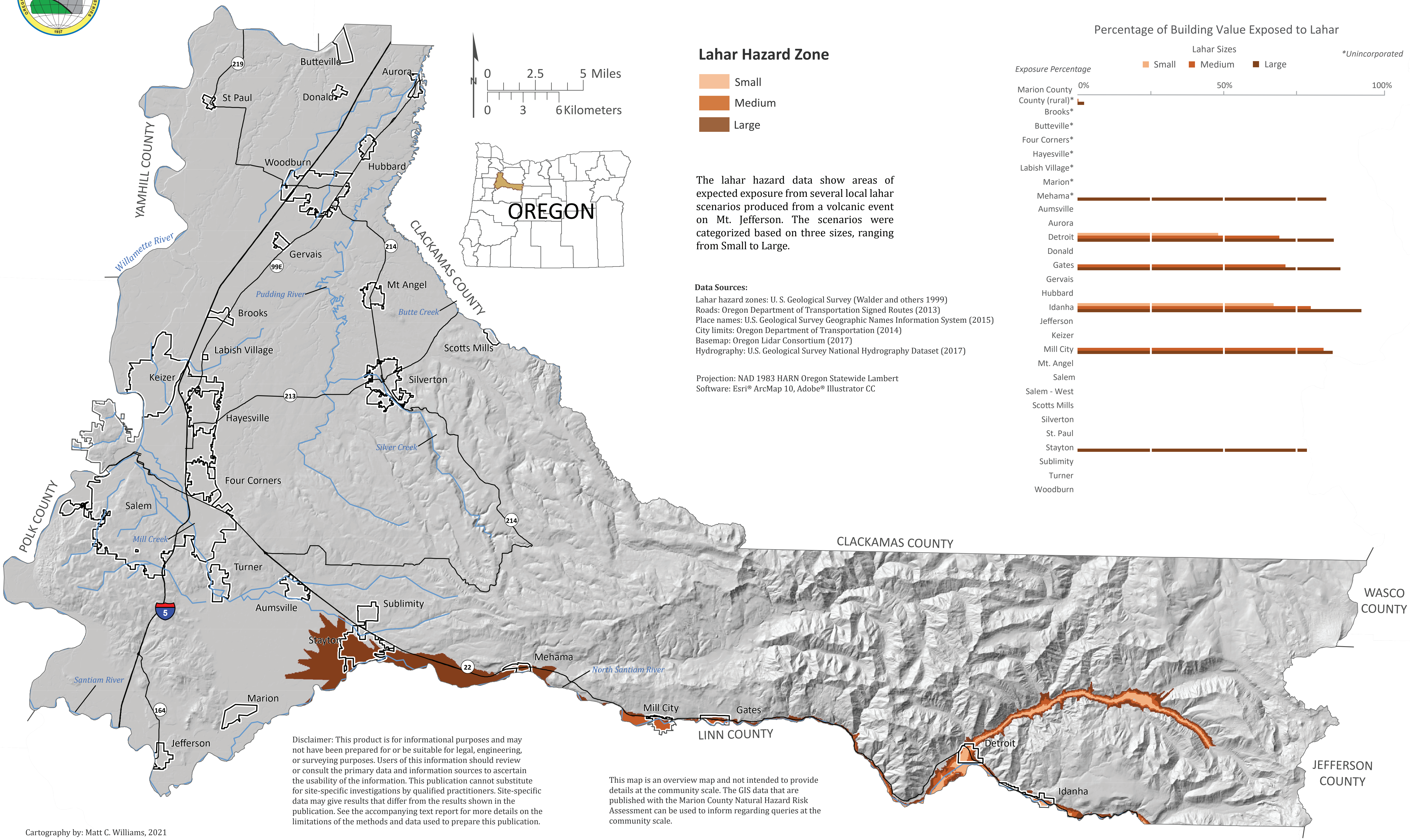
Cartography by: Matt C. Williams, 2021

Lahar Exposure Map of Marion County, Oregon

PLATE 8



Lahar Hazard Zone

- Small
- Medium
- Large

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:

Lahar hazard zones: U. S. Geological Survey (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 (2017)
Hydrography: U.S. Geological Survey National Hydrography Dataset (2017)

Projection: NAD 1983 HARN Oregon Statewide Lambert
Software: Esri® ArcMap 10, Adobe® Illustrator CC

Percentage of Building Value Exposed to Lahar

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Cartography by: Matt C. Williams, 2021

APPENDIX H: OCCRI FUTURE CLIMATE PROJECTIONS MARION COUNTY, OREGON

Future Climate Projections
Marion County, Oregon

June 2022

Oregon Climate Change Research Institute

Silver Creek and South Falls in Silver Falls State Park, Marion County, Oregon
Photograph by Rick Obst, CC BY-SA 4.0, via commons.wikimedia.org

OCCRI DLCD

Future Climate Projections: Marion County, Oregon

Report to the Oregon Department of Land Conservation and Development

Meghan Dalton, Erica Fleishman, Dominique Bachelet
Oregon Climate Change Research Institute
College of Earth, Ocean, and Atmospheric Sciences
104 CEOAS Admin Building
Oregon State University
Corvallis, OR 97331

June 2022

Table of Contents

Executive Summary

Climate change is expected to increase the occurrence of many climate-related natural hazards. 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 theoretical principles underlying increasing temperatures in response to ongoing emissions of greenhouse gases. 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 and consistency among models, yet these risks are influenced by multiple secondary factors in addition to increasing temperatures. Confidence in ochanges in risks is indicated as low if projections suggest relatively few to no changes or evidence is limited.

Table 1. Projected direction and level of confidence in changes in the risks of climate-related natural hazards. 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 Rains Flooding Wildfire	Heat Waves
Risk Unchanging =	Windstorms			
Risk Decreasing ↓				Cold Waves

This report presents future climate projections for Marion County relevant to specified natural hazards for the 2020s (2010–2039) and 2050s (2040–2069) relative to the 1971–2000 historical baseline. The projections are presented for a lower greenhouse gas emissions scenario (RCP 4.5) and a higher greenhouse gas emissions scenario (RCP 8.5), and are based on multiple global climate models. 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 are included in the main report.

Heat Waves

The number, duration, and intensity of extreme heat events is expected to increase as temperatures continue to warm.

In Marion 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 (RCP 4.5) and higher (RCP 8.5) emissions scenarios.

In Marion County, the number of days per year with temperatures 90°F or higher is projected to increase by an average of 16 days (range 5–27 days) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

In Marion County, 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, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

Cold Waves

Cold extremes will become less frequent and intense as the climate warms.

In Marion County, the number of cold days (maximum temperature 32°F or lower) per year is projected to decrease by an average of 4 days (range -2– -5 days) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

In Marion County, 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, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

Heavy Rains

The intensity of extreme precipitation is expected to increase as the atmosphere warms and holds more water vapor.

In Marion County, the number of days per year with at least 0.75 inches of precipitation is not projected to change substantially. However, 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 0–35%) and 11% (range 0–24%), respectively, relative to the1971–2000 historical baselines, under the higher emissions scenario.

In Marion County, 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

Winter flood risk at mid- to low elevations in Marion 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 summer soil moisture, low spring snowpack, low summer runoff, and low summer precipitation, is projected to become more frequent in Marion County by the 2050s.

Wildfire

Wildfire risk, expressed as the average number of days per year on which fire danger is very high, is projected to increase in Marion County by 13 days (range -6–32) by the 2050s, relative to the historical baseline, under the higher emissions scenario.

In Marion County, the average number of days per year on which vapor pressure deficit is extreme is projected to increase by 27 days (range 9–43) by the 2050s, compared to the historical baseline, under the higher emissions scenario.

Reduced Air Quality

The risk of wildfire smoke in Marion County is projected to increase. The number of days per year on which the concentration of wildfire-derived fine particulate matter results in poor air quality is projected to increase by 19%, and the concentration of fine particulate matter is projected to increase by 91%, from 2004–2009 to 2046–2051 under a medium emissions scenario.

Loss of Wetlands

In Marion 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.

Windstorms

Limited research suggests little if any change in the frequency and intensity of windstorms in the Northwest as a result of climate change.

Expansion of Non-native Invasive Species

In general, non-native invasive plant species in Marion County are likely to become more prevalent in response to projected increases in temperature, especially minimum winter temperature, and increases in 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). Climate change is expected to increase the likelihood of natural hazards such as heavy rains, river flooding, drought, heat waves, wildfires, and episodes of poor air quality, and to decrease the likelihood of cold waves.

Oregon's Department of Land Conservation and Development (DLCD) contracted with the Oregon Climate Change Research Institute (OCCRI) to analyze the influence of climate change on natural hazards. The scope of the analysis that yielded this report is limited to the geographic area encompassed by Marion, Linn, Lane, and Tillamook Counties, Oregon, which are the focus of the Pre-Disaster Mitigation (PDM) 19 grants that DLCD received from the Federal Emergency Management Agency. Products of OCCRI's analysis include county-specific data, graphics, and narrative summaries of climate projections related to ten climate-related natural hazards (Table 2). This information will be integrated into the Natural Hazards Mitigation Plan (NHMP) updates for the four counties, and can be used in other county plans, policies, and programs. In addition to the county reports, OCCRI will share data and provide other technical assistance to the counties. This report covers climate change projections related to natural hazards relevant to Marion County.

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 Rains 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**

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 refined 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. More information about the data sources is in the Appendix.

Global Climate Models

Global climate models (GCMs) are computer models of Earth's atmosphere, ocean, and land and their interactions over time and space. The models are grounded in the fundamental laws of physics. Over time the spatial resolution of the models has increased and more biological processes, such as wildfire emissions and dynamic vegetation, have been included (Figure 1). The latest GCMs from the sixth phase of the Coupled Model Intercomparison Project (CMIP6), the climate modeling foundation of the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report, generally have higher resolution, better represent Earth system processes, and improve simulation of recent mean values of climate change indicators relative to older versions of GCMs (IPCC, 2021). However, some CMIP6 models overestimate temperatures in the twentieth century, likely due to the difficulty of accurately simulating cloud dynamics. 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 produce its official warming projections given different fossil fuel emissions scenarios (Hausfather *et al.*, 2022).

Differences in simulations of Oregon's projected average temperature between the fifth phase of the Coupled Model Intercomparison Project (CMIP5) and CMIP6 were estimated in the Fifth Oregon Climate Assessment (Dalton and Fleishman, 2021). The CMIP6 models generally projected greater warming over Oregon than the CMIP5 models, largely because temperature in the CMIP6 models was more sensitive to a doubling of atmospheric carbon dioxide. The latter outcome reflected a larger amplification of temperature increases by clouds within the CMIP6 models (Dalton and Fleishman, 2021; IPCC, 2021), which may or may not be realistic (Hausfather *et al.*, 2022). In view of this uncertainty, and because downscaled data from CMIP6 are not yet widely available, this report presents the more conservative projections from CMIP5 GCMs.

GCMs are the most sophisticated tools for understanding Earth's climate, but they still simplify the climate system. Because there are several ways to implement such simplifications, different GCMs yield somewhat different projections. Accordingly, it is best practice to average and report the range of projections from at least ten GCMs that simulate the historical climate well (Mote *et al.*, 2011; Hausfather *et al.*, 2022). More information about GCMs and uncertainty is in the Appendix.

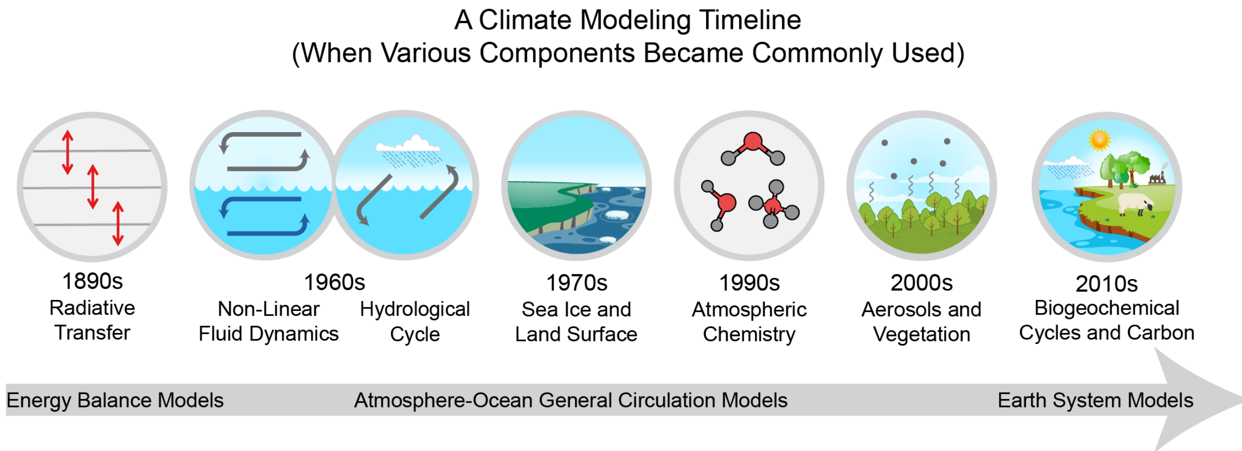

Figure 1. As scientific understanding of climate has evolved over the last 120 years, increasing amounts of physics, chemistry, and biology have been incorporated into calculations and, eventually, models. Various processes and components of the climate system became regularly included in scientific understanding of global climate calculations and, over the second half of the century as computing resources became available, formalized in global climate models. (Source: science2017.globalchange.gov)

Greenhouse Gas Emissions

When scientists use GCMs to project climate, they make assumptions about the quantity of future global emissions of greenhouse gases. The GCMs then simulate the effects of those emissions on the air, ocean, 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 on which future climate projections in this report are based used Representative Concentration Pathways (RCPs) that describe different levels of radiative forcing. Radiative forcing is the total amount of energy retained in the atmosphere via changes in incoming solar radiation, reflectivity of the Earth's surface, and concentrations of heat-trapping greenhouse gases by 2100. A fixed greenhouse gas emissions trajectory was associated with each pathway. The higher the volume of global emissions, the greater the projected increase in global temperature (Figure 2). CMIP6 models used shared socio-economic pathways (SSPs) that reflect sets of social and economic assumptions and can be associated with the different levels of emissions of CMIP5 RCPs (IPCC, 2021). Projections in this report assume a lower emissions pathway (RCP 4.5) and a higher emissions pathway (RCP 8.5). These are the most commonly used pathways, or scenarios, in the peer-reviewed literature, and downscaled data representing the effects of these scenarios on local climate are available. More information about emissions scenarios is in the Appendix.

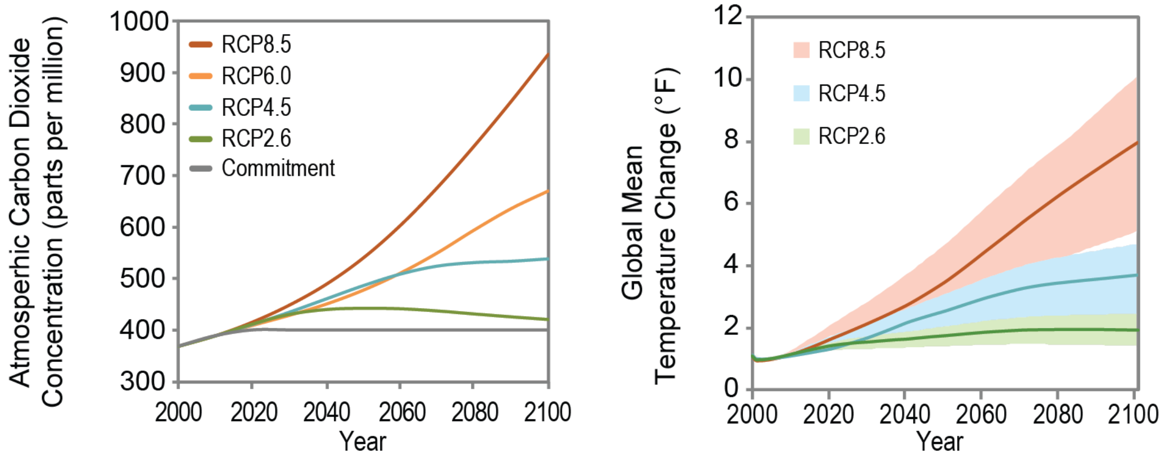

Figure 2. Future scenarios of atmospheric carbon dioxide concentrations (left) and projections of global temperature change (right) resulting from several different emissions scenarios, called Representative Concentration Pathways (RCPs), that were considered in the fourth National Climate Assessment. (Source: science2017.globalchange.gov)

Downscaling

Global climate models simulate the climate across contiguous grid cells at coarse spatial resolutions, such that only one to three grid cells cover the state of Oregon. To make these coarse-resolution simulations more locally relevant, GCM outputs are combined with historical observations, yielding higher-resolution projections. This process is called statistical downscaling. 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.

Future Time Periods

When analyzing GCM 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 the 30 recent past simulated years is called the *historical baseline*. This report presents projections averaged over two future 30-year periods, 2010–2039 (2020s) and 2040–2069 (2050s), relative to the historical baseline from 1971–2000 (Table 3).

Because each of the 20 GCMs is based on slightly different assumptions, each yields a slightly different value for the historical baseline. Therefore, this report presents the average and range of projected *changes* in values of climate variables relative to each model's historical baseline rather than presenting the average and range of projected absolute values of variables. The average of the 20 historical baselines, the *average historical baseline*, is also presented to aid in understanding the relative magnitude of projected changes. The 20-model average projected future change that is listed in the tables can be added to the 20-model average historical baseline, also listed in the tables, to infer the 20-model average projected future value of a given variable.

Table 3. Historical and future time periods over which projections were averaged.

Historical Baseline	2020s	2050s
1971–2000	2010–2039	2040–2069

How to Use the Information in this Report

Because the observational record may not include many values of climate variables nor the frequency of some extreme conditions that are projected to occur in the future, 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 considered as predictions of the weather on a specified date, but rather as projections of climate, which is the long-term statistical aggregate of weather.[1]

The projected direction and magnitude of change in values of climate variables in this report are best interpreted relative to the historical climate conditions under which a particular asset or system was designed to operate. For this reason, considering the projected changes between the historical and future periods allows one to envision how natural and human systems of interest will 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 this report.

The information in this report can be used to

- Explore a range of plausible future outcomes that take into consideration the climate system's complex response to increasing concentrations of greenhouse gases
- Envision how current systems may respond under climate conditions different from those under which the systems were designed to operate
- Inform evaluation of potential mitigation actions within hazard mitigation plans to accommodate future conditions
- Inform a risk assessment in terms of the likelihood of occurrence of a particular climate-related hazard

[1] Read more: https://nca2014.globalchange.gov/report/appendices/faqs#narrative-page-38784

Average Temperature

Oregon's average temperature warmed at a rate of 2.2°F per century from 1895 through 2019 (Dalton and Fleishman, 2021). Average temperature is expected to continue increasing during the twenty-first century if global emissions of greenhouse gases continue; 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 of 1.8–5.4°F) under a lower emissions scenario (RCP 4.5) and by 5.0°F (range of 2.9–6.9°F) under a higher emissions scenario (RCP 8.5) (Dalton *et al.*, 2017; Dalton and Fleishman, 2021). Furthermore, summers are projected to warm more than other seasons (Dalton *et al.*, 2017; Dalton and Fleishman, 2021).

During the twenty-first century, average temperature in Marion County is projected to warm at a rate similar to that of Oregon as a whole (Figure 3). Projected increases in average temperature in Marion County relative to the 1971–2000 historical baseline in each global climate model (GCM) range from 1.0–3.5°F by the 2020s (2010–2039) and 1.5–6.6°F by the 2050s (2040–2069), depending on emissions scenario and GCM (Table 4).

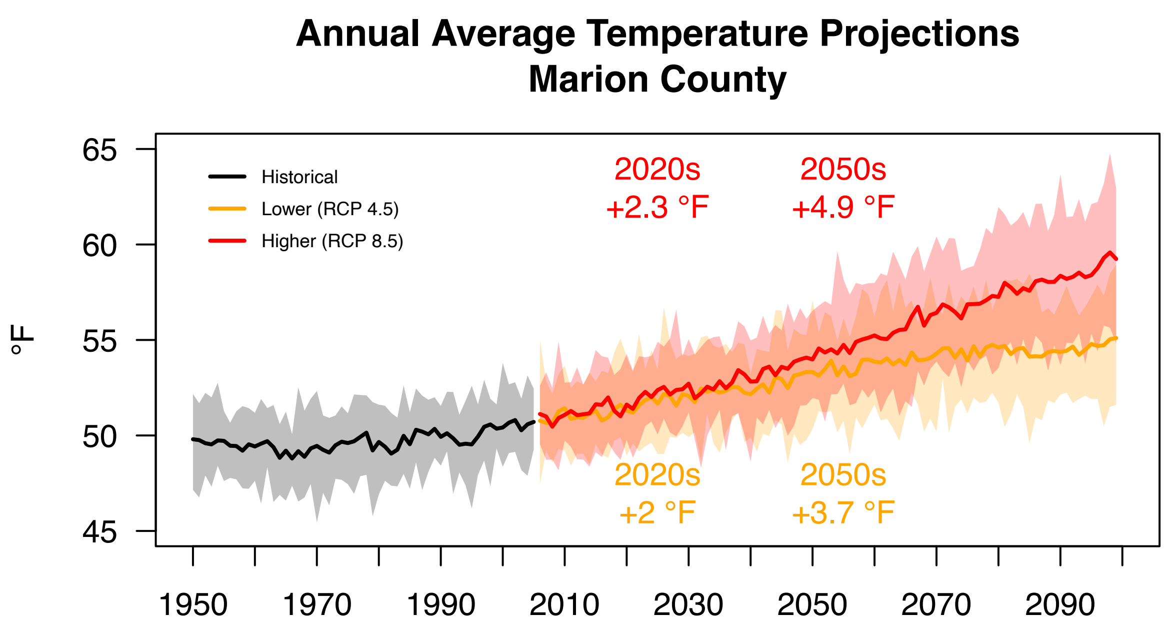

Figure 3. Projected annual average temperature in Marion County as simulated by 20 downscaled global climate models under a lower (RCP 4.5) and a higher (RCP 8.5) greenhouse gas emissions scenario. Solid lines and shading represent the 20-model mean and range, respectively. The figure shows the multiple-model mean differences for the 2020s (2010–2039 average) and the 2050s (2040–2069 average) relative to the average historical baseline (1971–2000 average).

Table 4. Projected future changes from the 1971–2000 baseline in Marion County's annual temperature calculated for each of 20 global climate models and averaged across the 20 models (range in parentheses) for two emissions scenarios and two future time periods.

Emissions Scenario	2020s (2010–2039 average)	2050s (2040–2069)
Higher (RCP 8.5)	+2.3°F (1.4–3.5)	+4.9°F (2.8–6.6)
Lower (RCP 4.5)	+2.0°F (1.0–3.1)	+3.7°F (1.5–5.1)

Heat Waves

Extreme heat has become more frequent and intense worldwide since the 1950s, largely due to human-caused climate change (IPCC, 2021). The number, duration, and intensity of extreme heat events in Oregon is projected to increase due to continued warming temperatures. In fact, the temperature on the hottest days in summer is projected to increase even more than the mean summer temperature in the Northwest (Dalton *et al.*, 2017). Heat waves occur periodically as a result of natural variability, but human-caused climate change is increasing their severity (Vose *et al.*, 2017). In addition, evidence of increases in summer extreme heat events that are defined by nighttime minimum temperatures is stronger than evidence of increases in extreme heat events that are defined by maximum temperatures (Dalton and Fleishman, 2021).

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. This report presents projected changes in three metrics of extremes daytime heat (maximum temperature) and nighttime heat (minimum temperature) (Table 5).

Table 5. 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

In Marion 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 (Table 6, Figure 4, Figure 5). For example, 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 5–27. The average number of hot days per year is projected to be 16 more than the average historical baseline of 4 days. The average number of warm nights per year is projected to be 5 more than the average historical baseline of virtually zero.

Similarly, under the higher emissions scenario, the temperature on the hottest day of the year is projected to increase by 1.7–9.7°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 91.2°F. The average projected increase in temperature on the warmest night is 5.8°F above the average historical baseline of 62.3°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 2.3 and 0.7, respectively, above the average historical baseline of 0.5 and zero (Table 6, Figure 6).

Table 6. Projected future changes from the 1971–2000 baseline in Marion County's extreme heat metrics 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 the 2020s (2010–2039 average) and 2050s (2040–2069 average). The 20-model average projected future change that is listed in the table can be added to the 20-model average historical baseline, also listed in the table, to infer the 20-model average projected future value of a given variable.

	Average Historical Baseline	2020s		2050s	
		Lower	Higher	Lower	Higher
Hot Days	3.6 days	3.8 days (1.6-6.9)	5.2 days (2.4-7.5)	9.5 days (4.1-16.2)	15.8 days (4.6-26.6)
Warm Nights	0.4 days	0.7 days (0-1.8)	1 days (0.2-2.1)	2.5 days (0.2-6.3)	5.4 days (1.1-14.1)
Hottest Day	91.2°F	2.5°F (0.5-3.9)	3.2°F (1.2-5.5)	5°F (1.8-8.6)	6.8°F (1.7-9.7)
Warmest Night	62.3°F	2°F (0-4)	2.5°F (1.1-3.8)	4°F (0.9-6.8)	5.8°F (2.6-8.8)
Daytime Heat Waves	0.5 events	0.6 events (0.2-1.1)	0.8 events (0.4-1.3)	1.5 events (0.8-2.3)	2.3 events (0.8-3.4)
Nighttime Heat Waves	0 events	0.1 events (0-0.3)	0.1 events (0-0.3)	0.3 events (0-0.8)	0.7 events (0-1.8)

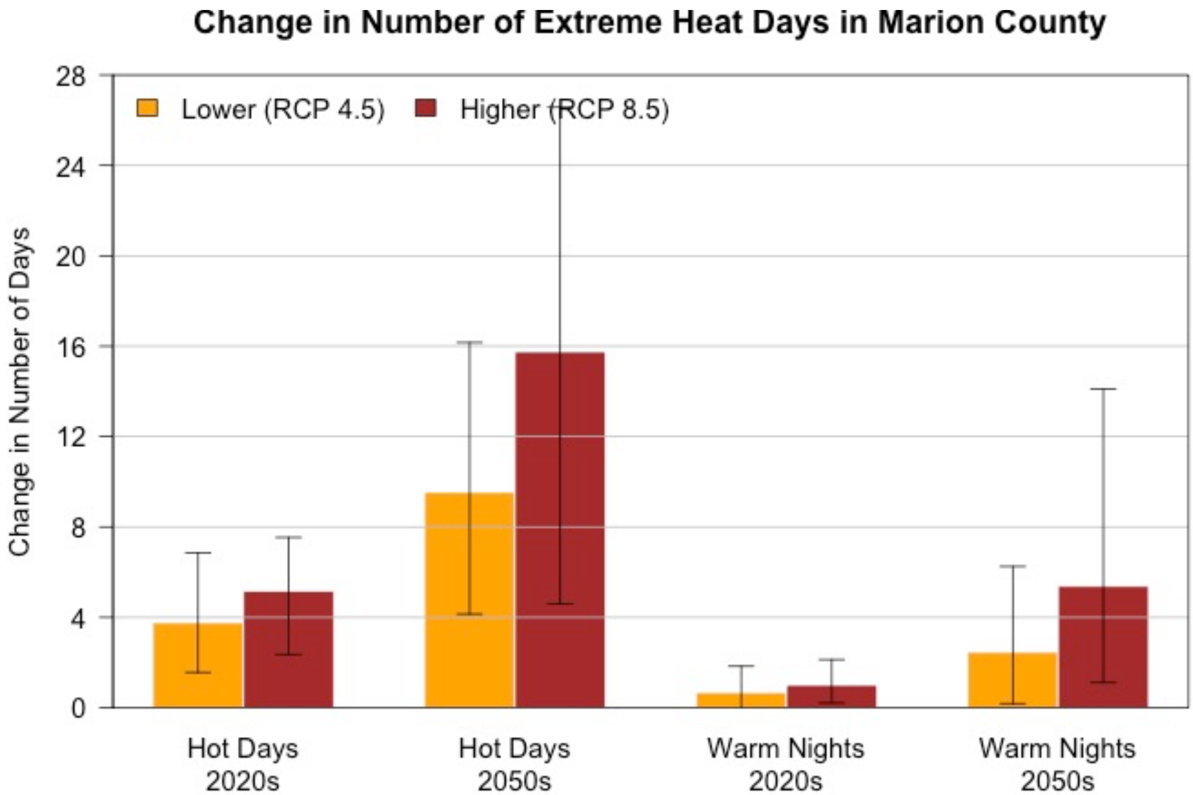

Figure 4. Projected changes in the number of hot days (left two sets of bars) and warm nights (right two sets of bars) in Marion County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged across the 20 models. Whiskers represent the range of changes across 20 models. Hot days are those on which the maximum temperature is 90°F or higher; warm nights are those on which the minimum temperature is 65°F or higher.

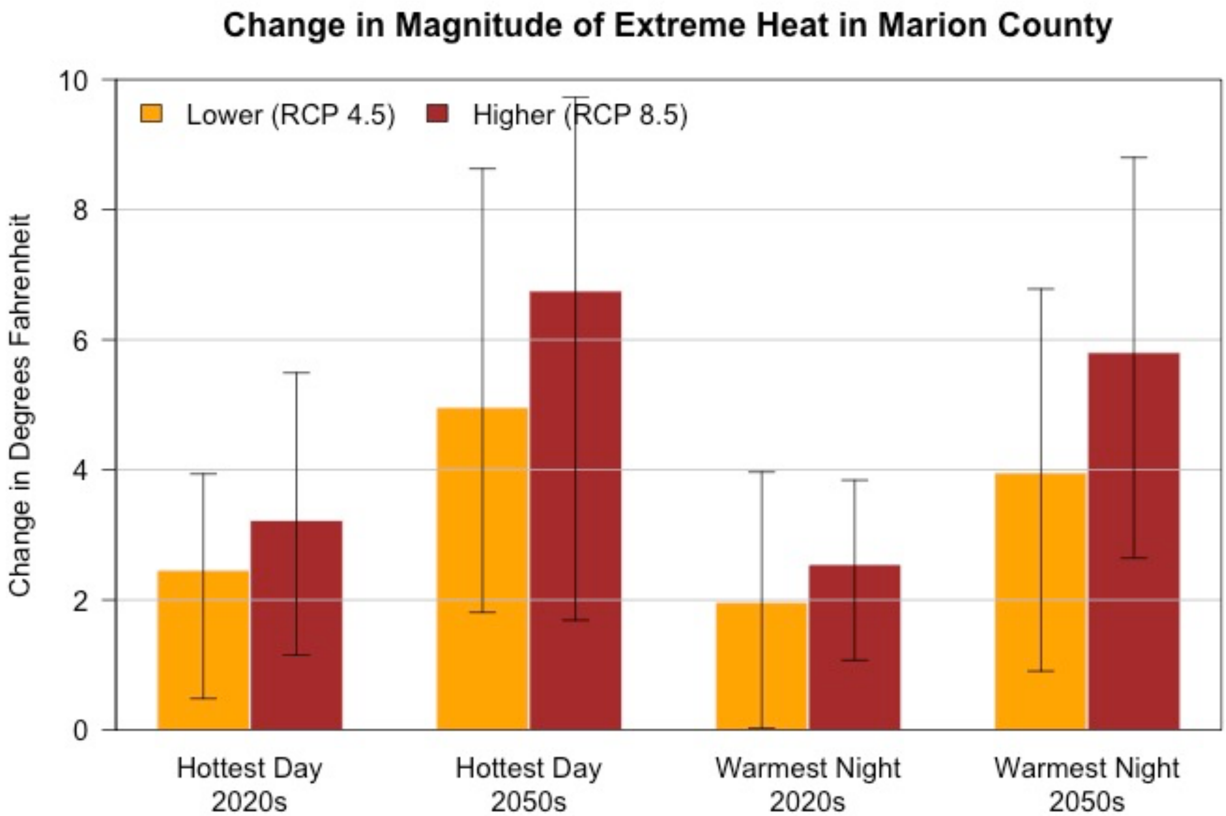

Figure 5. Projected changes in the temperature on the hottest day of the year (left two sets of bars) and warmest night of the year (right two sets of bars) in Marion County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged across the 20 models. Whiskers represent the range of changes across 20 models.

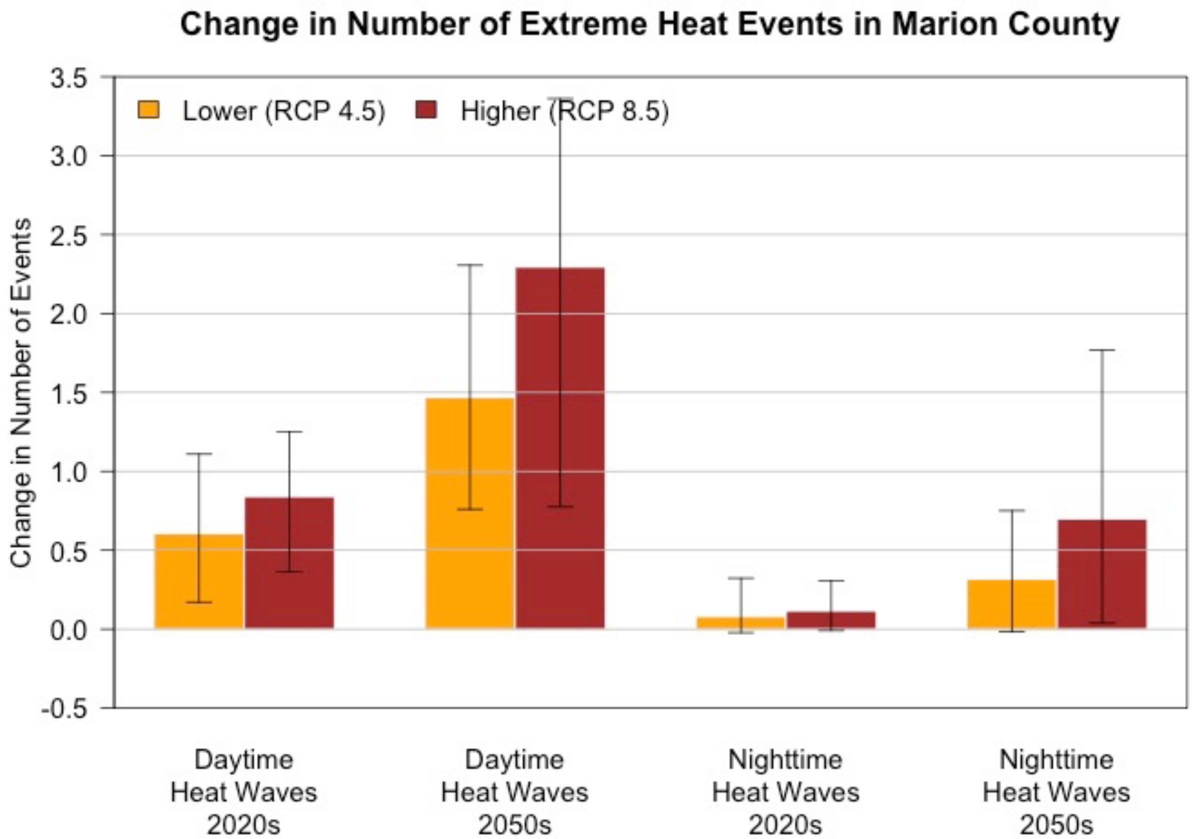

Figure 6. Projected changes in the number of daytime heat waves (left two sets of bars) and nighttime heat waves (right two sets of bars) in Marion County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged across the 20 models. Whiskers represent the range of changes across 20 models. Daytime heat waves are defined as three or more consecutive days on which the maximum temperature is 90°F or higher; nighttime heat waves are three or more consecutive days on which the minimum temperature is 65°F or higher.

Key Messages

⇒ The number, duration, and intensity of extreme heat events is expected to increase as temperatures continue to warm.

⇒ In Marion 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 (RCP 4.5) and higher (RCP 8.5) emissions scenarios.

⇒ In Marion County, the number of days per year with temperatures 90°F or higher is projected to increase by an average of 16 days (range 5–27 days) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

⇒ In Marion County, 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, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

Cold Waves

Over the past century, cold extremes have become less frequent and severe in the Northwest and worldwide. This trend is driven by human-caused climate change and is expected to continue (Vose *et al.*, 2017; IPCC, 2021). This report presents projected changes in three metrics of extreme daytime cold (maximum temperature) and nighttime cold (minimum temperature) (Table 7).

Table 7. 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

In Marion County, the number of cold days and nights is projected to decrease by the 2020s (2010–2039) and 2050s (2040–2069) under both the lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios (Table 8, Figure 7). For example, climate models projected that by the 2050s under the higher emissions scenario, the number of cold days will decrease by 2–5 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. Nighttime temperatures rarely are lower than 0°F in Marion County.

Similarly, the temperatures on the coldest day and night are projected to increase by the 2020s and 2050s under both emissions scenarios (Table 8, Figure 8). For example, by the 2050s under the higher emissions scenario, the temperature on the coldest night of the year is projected to increase by 0.5–10.5°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 13.9°F. The average projected increase in the temperature on the coldest day is 5.0°F above the average historical baseline of 29.0°F. However, daytime and nighttime cold waves are rare in Marion County (Table 8, Figure 7, Figure 9).

Table 8. Projected future changes from the 1971–2000 baseline in Marion County's extreme cold metrics 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 the 2020s (2010–2039 average) and 2050s (2040–2069 average). The 20-model average projected future change that is listed in the table can be added to the 20-model average historical baseline, also listed in the table, to infer the 20-model average projected future value of a given variable.

	Average Historical Baseline	2020s		2050s	
		Lower	Higher	Lower	Higher
Cold Days	5.2 days	-1.6 days (-3.4 - 0.6)	-2.3 days (-3.8 - -0.7)	-3.1 days (-4.2 - -1.3)	-3.5 days (-5.1 - -1.6)
Cold Nights	0.1 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°F	1.3°F (-2.9 - 3.5)	2.6°F (-1.4 - 5.2)	4°F (0.4 - 7.9)	5°F (1 - 8.4)
Coldest Night	13.9°F	1.5°F (-2.3 - 4.9)	3.1°F (-0.5 - 6.9)	4.8°F (1 - 8.7)	6°F (0.5 - 10.5)
Daytime Cold Waves	0.6 events	-0.2 events (-0.5 - 0.1)	-0.3 events (-0.5 - -0.1)	-0.4 events (-0.6 - -0.1)	-0.4 events (-0.7 - -0.1)
Nighttime Cold Waves	0 events	0 events (0 - 0)	0 events (0 - 0)	0 events (0 - 0)	0 events (0 - 0)

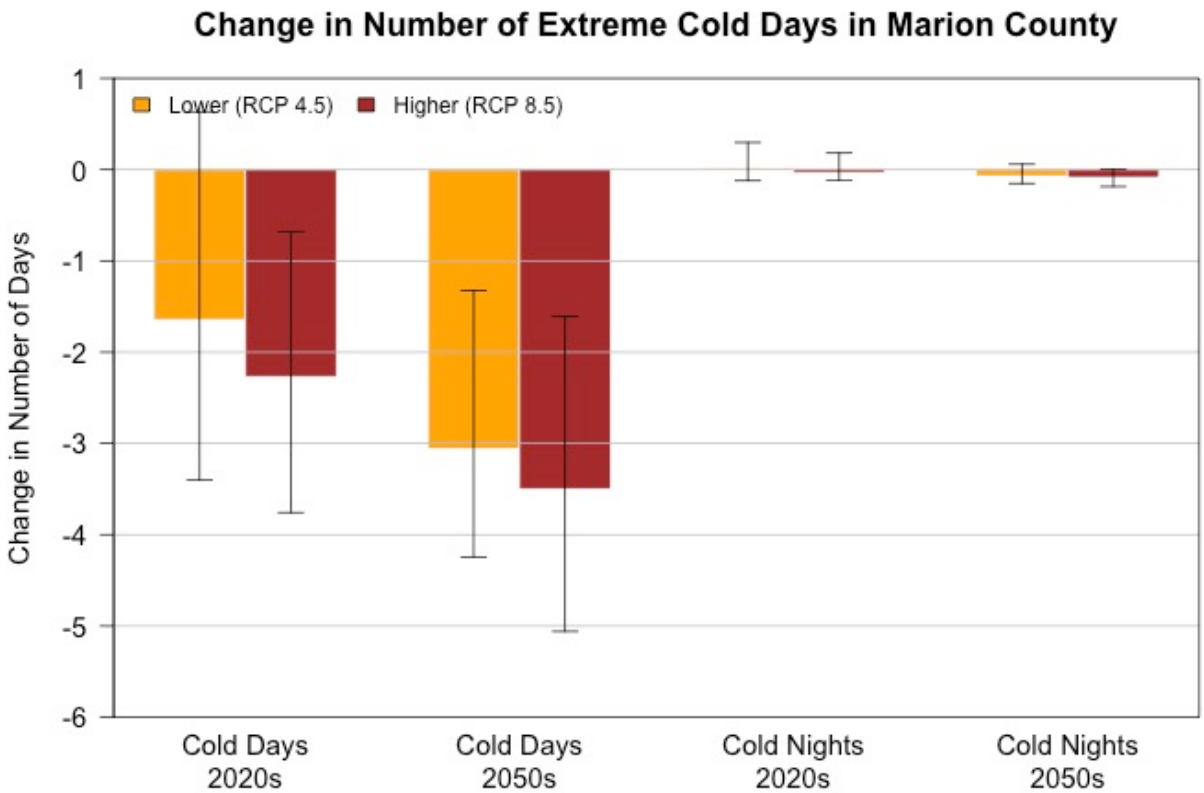

Figure 7. Projected changes in the number of cold days (left two sets of bars) and cold nights (right two sets of bars) in Marion County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged across the 20 models. Whiskers represent the range of changes across 20 models. Cold days are those on which the maximum temperature is 32°F or lower; cold nights are those on which the minimum temperature is 0°F or lower.

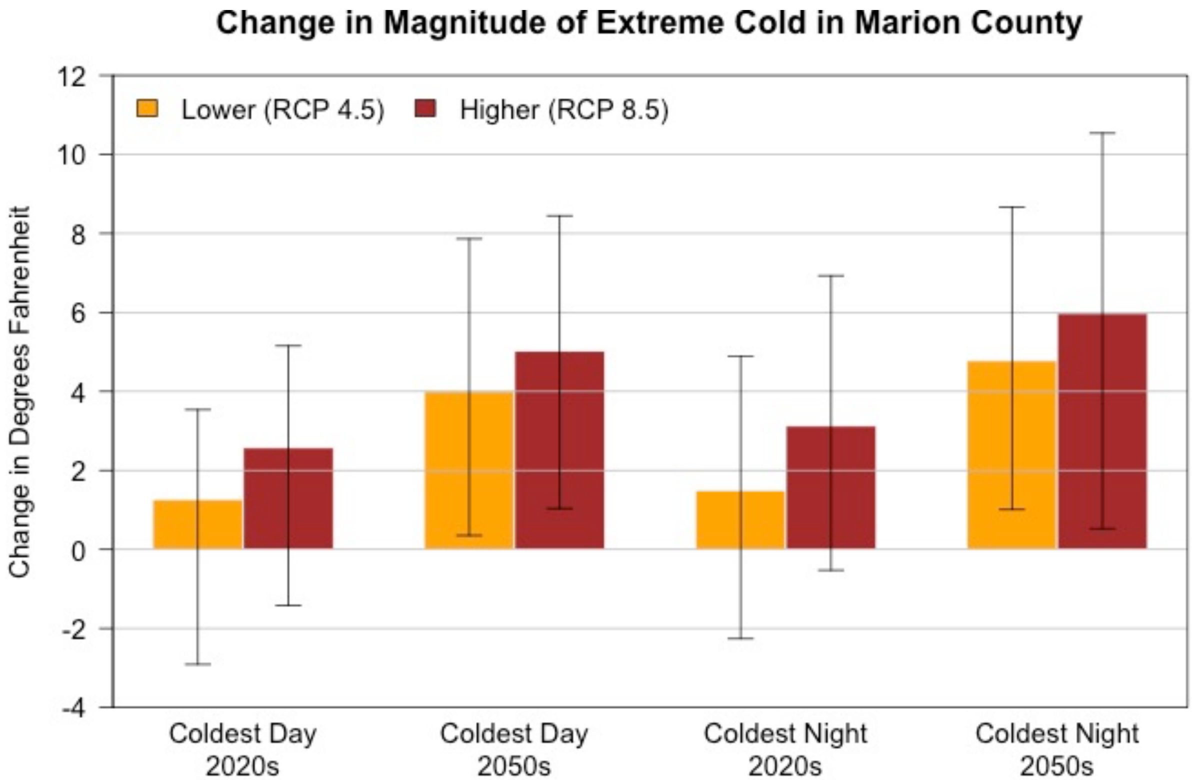

Figure 8. Projected changes in the temperature on the coldest day of the year (left two sets of bars) and coldest night of the year (right two sets of bars) in Marion County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged across the 20 models. Whiskers represent the range of changes across 20 models.

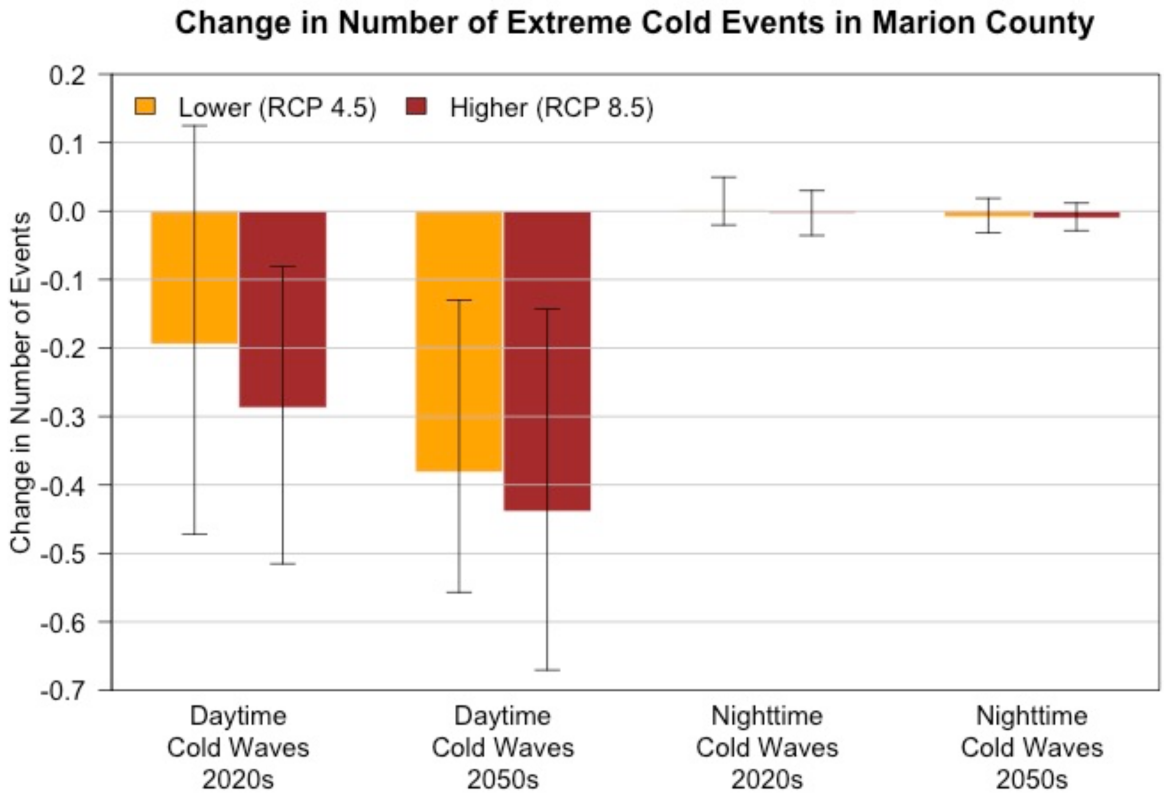

Figure 9. Projected changes in the number of daytime cold waves (left two sets of bars) and nighttime cold waves (right two sets of bars) in Marion County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged across the 20 models. Whiskers represent the range of changes across 20 models. Daytime cold waves are defined as three or more consecutive days on which the maximum temperature is 32°F or lower; nighttime cold waves are three or more consecutive days on which the minimum temperature is 0°F or lower.

Key Messages

⇒ Cold extremes will become less frequent and intense as the climate warms.

⇒ In Marion County, the number of cold days (maximum temperature 32°F or lower) per year is projected to decrease by an average of 4 days (range -2– -5 days) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

⇒ In Marion County, 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, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

Heavy Rains

There is greater uncertainty in projections of future precipitation than projections of future temperature. Precipitation has high natural variability, and the atmospheric patterns that influence precipitation are represented differently among GCMs. Global 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).

Observed annual precipitation in Oregon has high year-to-year variability and has not changed significantly; future trends in annual precipitation are expected to be dominated by natural variability (Dalton *et al.*, 2017; Dalton and Fleishman, 2021). On average, summers in Oregon are projected to become drier and other seasons to become wetter, resulting in a slight increase in annual precipitation by the 2050s. However, some models project increases and others decreases in each season (Dalton *et al.*, 2017). 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).

Extreme precipitation events in the Northwest are 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 events across large areas west of the Cascade Range. By contrast, low pressure systems that are not driven by westerly flows from offshore 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 land areas worldwide since the 1950s (IPCC, 2021). Observed trends in the frequency of extreme precipitation events 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, including atmospheric rivers, is expected to increase (Dalton *et al.*, 2017; Kossin *et al.*, 2017; Dalton and Fleishman, 2021). Regional climate models project a larger increase in precipitation extremes east of the Cascade Range than west of the Cascade Range (Mote *et al.*, 2019). Atmospheric rivers are associated with the majority of fall and winter extreme precipitation events in Oregon. Climate models project an increase in the number of days on which an atmospheric river is present, and they project that atmospheric rivers will account for an increasing proportion of total annual precipitation across the Northwest (Dalton and Fleishman, 2021). This report presents projected changes in four metrics of precipitation extremes (Table 9).

Table 9. 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 Marion County, the amount of precipitation on the wettest day and wettest consecutive five days 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 10, Figure 10). However, some models project decreases in these metrics for certain time periods and scenarios.

Climate models project that 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, will increase by 0.2–34.5% (Figure 10). The average projected amount of precipitation on the wettest day of the year is 14.4% greater than the average historical baseline of 2.4 inches.

Climate models project that by the 2050s under the higher emissions scenario, the amount of precipitation on the wettest consecutive five days of the year will change by -0.4–23.5% (Figure 10). The average projected amount of precipitation on the wettest consecutive five days is 10.6% above the average historical baseline of 6.1 inches.

The average number of days per year on which precipitation exceeds 0.75 inches is not projected to change substantially (Figure 11). For example, by the 2050s under the higher emissions scenario, the number of wet days per year is projected to increase by 0.7 (range -3.4–3.4). The historical baseline is an average of 23 days per year.

Landslides are often triggered by rainfall when the soil becomes saturated. As a surrogate measure of landslide risk, this report presents a threshold based on recent rainfall (cumulative precipitation over the previous 3 days) and antecedent precipitation (cumulative precipitation on the 15 days prior to the previous 3 days). By the 2050s under the higher emissions scenario, the average number of days per year in Marion County on which the landslide risk threshold is exceeded is projected to remain about the same, with a change of -0.2 days (range -2.7–3.7 days) (Figure 11). The historical baseline is an average of 28 days per year. Landslide risk depends on multiple site-specific factors, and this metric does not reflect all aspects of the hazard. The landslide risk threshold was developed for Seattle, Washington, and may be less applicable to other locations.

Landslide risk also can become high when heavy precipitation falls on an area that burned within approximately the past five to ten years. By the year 2100, under the higher emissions scenario, the probability that an extreme rainfall event will occur within one year after an extreme fire-weather event in Oregon or Washington was projected to increase by 700% relative to 1980–2005 (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.

Table 10. Projected future changes from the 1971–2000 baseline in Marion County's extreme precipitation metrics 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 the 2020s (2010–2039 average) and 2050s (2040–2069 average). The 20-model average projected future change that is listed in the table can be added to the 20-model average historical baseline, also listed in the table, to infer the 20-model average projected future value of a given variable.

	Average Historical Baseline	2020s		2050s	
		Lower	Higher	Lower	Higher
Wettest Day	2.4 inches	7.8% (-6.9-18.6)	6.8% (-4.2-21.5)	12.1% (4.1-24.6)	14.4% (0.2-34.5)
Wettest Five-Days	6.1 inches	5.4% (-7.2-18.1)	3.9% (-7.4-20)	8.7% (-3.4-23.7)	10.6% (-0.4-23.5)
Wet Days	22.5 days	0.2 days (-1.9-2.5)	-0.2 days (-2.9-1.8)	0.7 days (-2.6-3)	0.7 days (-3.4-3.4)
Landslide Risk Days	27.9 days	-0.1 days (-2.4-3)	-0.4 days (-3.1-2.2)	-0.3 days (-2.9-2.6)	-0.2 days (-2.7-3.7)

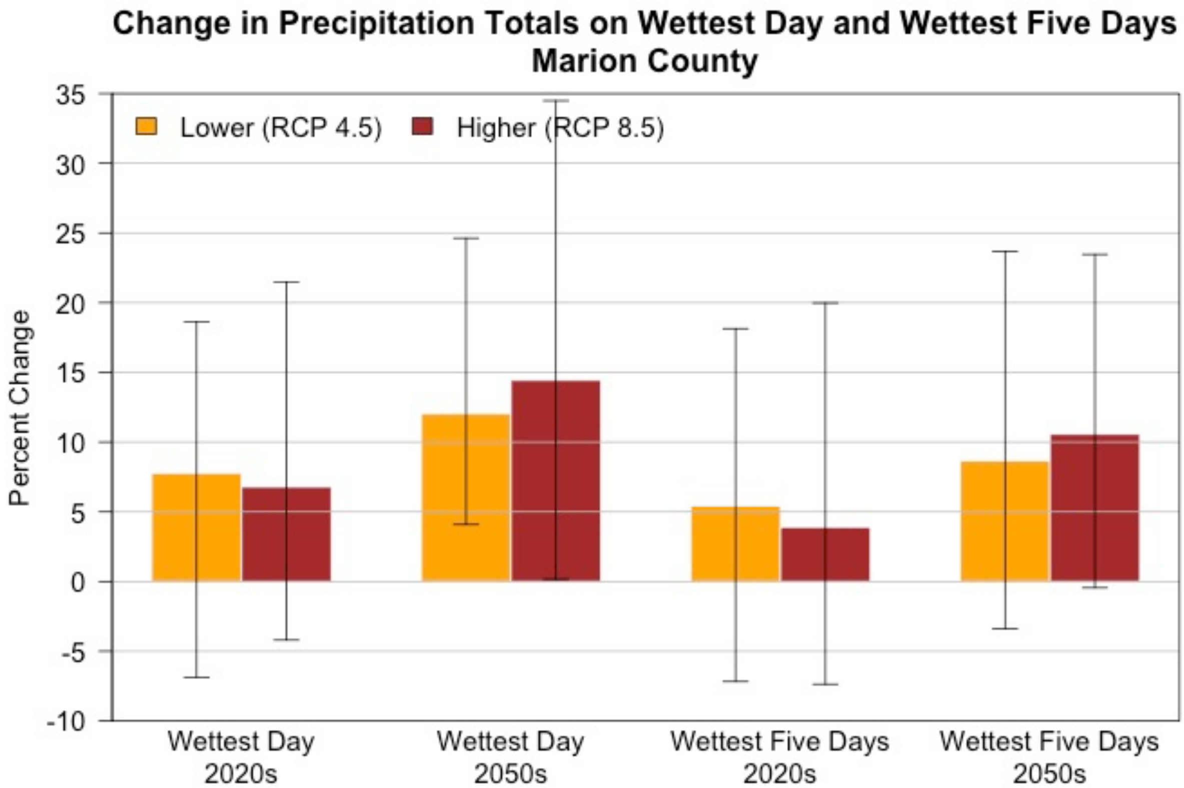

Figure 10. Projected percent changes in the amount of precipitation on the wettest day of the year (left two sets of bars) and wettest consecutive five days of the year (right two sets of bars) in Marion County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged across the 20 models. Whiskers represent the range of changes across 20 models.

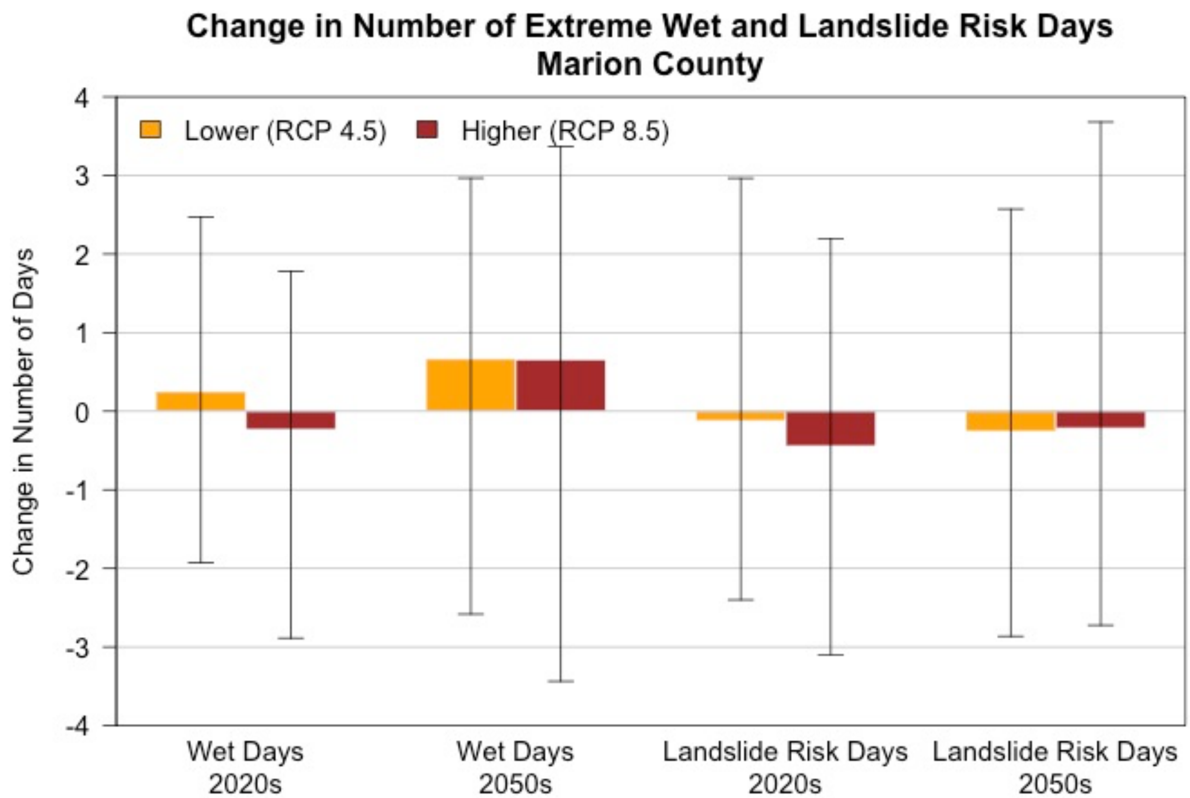

Figure 11. Projected changes in the number of wet days (left two sets of bars) and landslide risk days (right two sets of bars) in Marion County by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the historical baseline (1971–2000 average), under two emissions scenarios. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged across the 20 models. Whiskers represent the range of changes across 20 models.

Key Messages

⇒ The intensity of extreme precipitation is expected to increase as the atmosphere warms and holds more water vapor.

⇒ In Marion County, the number of days per year with at least 0.75 inches of precipitation is not projected to change substantially. However, 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 0–35%) and 11% (range 0–24%), respectively, relative to the1971–2000 historical baselines, under the higher emissions scenario.

⇒ In Marion County, 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 to result from increases in the intensity of heavy precipitation; warmer temperatures that cause more precipitation to fall as rain and less as snow, in turn causing snow to melt earlier in spring; and increasing winter precipitation and decreasing summer precipitation (Dalton *et al.*, 2017; Mote *et al.*, 2019; Dalton and Fleishman, 2021).

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). Recent 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, which 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 monthly hydrograph of the Willamette River at Salem reflects that the basin currently is rain-dominated, with peak flow during winter (Figure 12), whereas the Santiam River at Detroit Dam is in a mixed rain-and-snow basin in which flow peaks during winter and during spring snowmelt (Figure 13). By the 2050s (2040–2069), under both emissions scenarios, winter streamflow in the Willamette River at Salem is projected to increase due to increased winter precipitation. The monthly hydrograph of the Santiam River at Detroit Dam is projected to shift as the basin becomes rain-dominated; winter flow will increase the snowpack will melt earlier as temperatures increase and a greater percentage of precipitation falls 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.

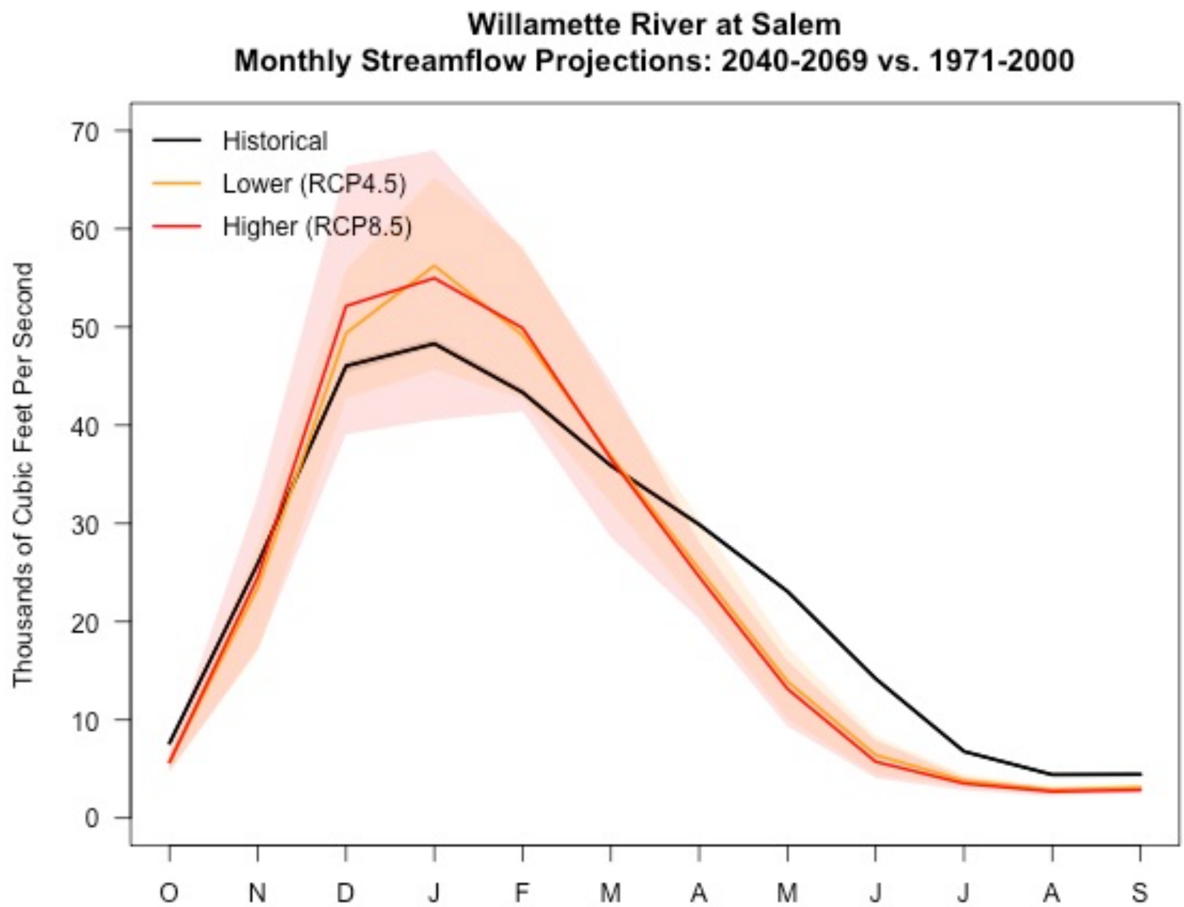

Figure 12. Simulated monthly, bias-corrected, non-regulated streamflow at the Willamette River at Salem in 2040–2069 compared to 1971–2000. Solid lines and shading represent the mean and range across ten global climate models. (Data source: Integrated Scenarios of the Future Northwest Environment, https://climatetoolbox.org/tool/future-streamflows)

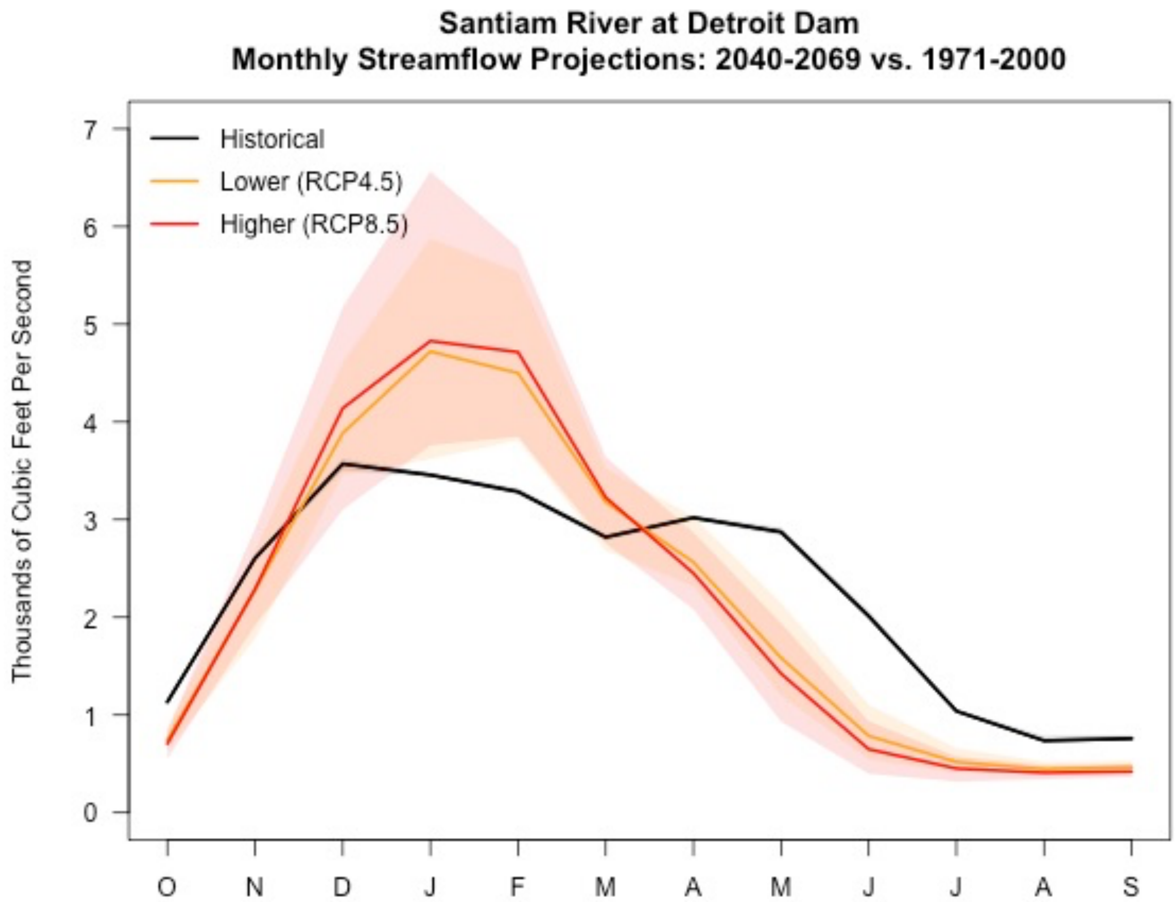

Figure 13. Simulated monthly, bias-corrected, non-regulated streamflow at the Santiam River at Detroit Dam in 2040–2069 compared to 1971–2000. Solid lines and shading represent the mean and range across ten global climate models. (Data source: Integrated Scenarios of the Future Northwest Environment, https://climatetoolbox.org/tool/future-streamflows)

Averaged across the western United States, major floods are projected to increase by 14–19% by the 2020s, 21–30% by 2040–2069 and by 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 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). This report describes projected changes in single-day flood levels for two locations in Marion County in terms of the magnitude of water-year maximum daily flows with 2-year, 10-year, 25-year, and 100-year return periods (50%, 10%, 4%, and 1% probability, respectively, that this daily flow magnitude will be exceeded in a given year) (Table 11). Flood magnitudes are compared between a historical baseline period (1961–2010 or 1950–1999) and the 2050s (2031–2080) or the late twenty-first century (2050–2099). The results of the flood analysis 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 are exploratory and should not be applied to engineering or design.

On the Willamette River at Salem, flood levels with 10-year and 100-year return periods (10% and 1% probability that this flood level would be exceeded in a given year) were projected to increase by 37% and 43%, respectively, from 1950-1999 to 2050-2099 under the higher emissions scenario (Queen *et al.*, 2021) (Table 11).

On the Willamette River at Salem, the average magnitudes of single-day floods with 2-year, 10-year, and 25-year return periods were projected to increase by 10%, 23%, and 29%, respectively, by the 2050s, compared to 1961–2010, under the higher emissions scenarios (RCP 8.5) (Figure 14). 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 scenarios (RCP 8.5) (Figure 15). However, a few models projected no change or decreases in the magnitude of maximum daily flows for each return period.

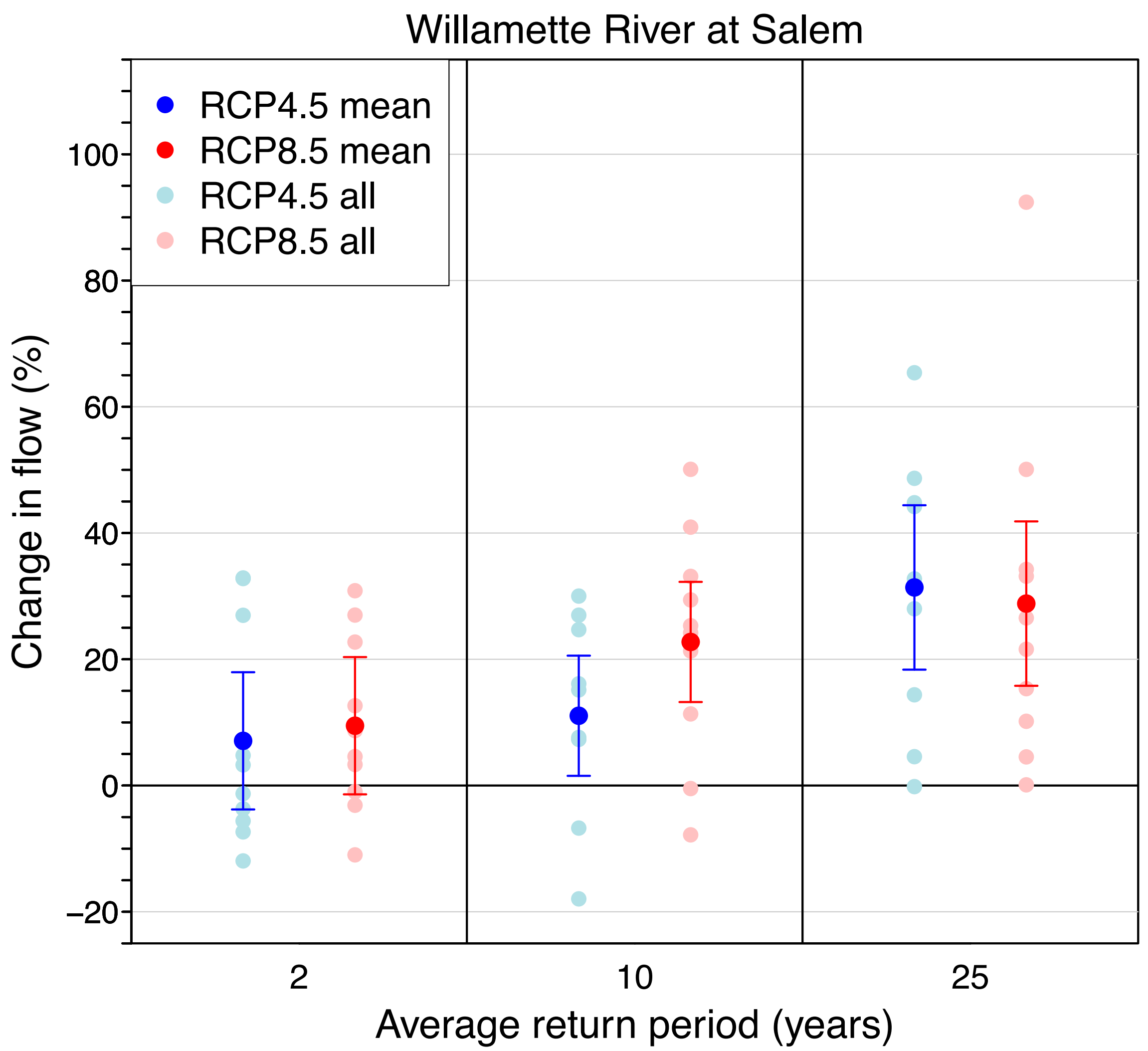

Figure 14. Projected change in water-year maximum daily, non-regulated streamflows with 2-year, 10-year, and 25-year return periods for the Willamette River at Salem from 1961–2010 to 2031–2080 under lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios. Larger blue and red dots and bars represent the mean and two standard errors across ten global climate models. Only a subset of the full set of 20 models simulated future hydrology (see Appendix). Smaller light blue and light red dots represent individual models. (Data source: Integrated Scenarios of the Future Northwest Environment, https://climate.northwestknowledge.net/IntegratedScenarios/; Figure source: David Rupp, OCCRI)

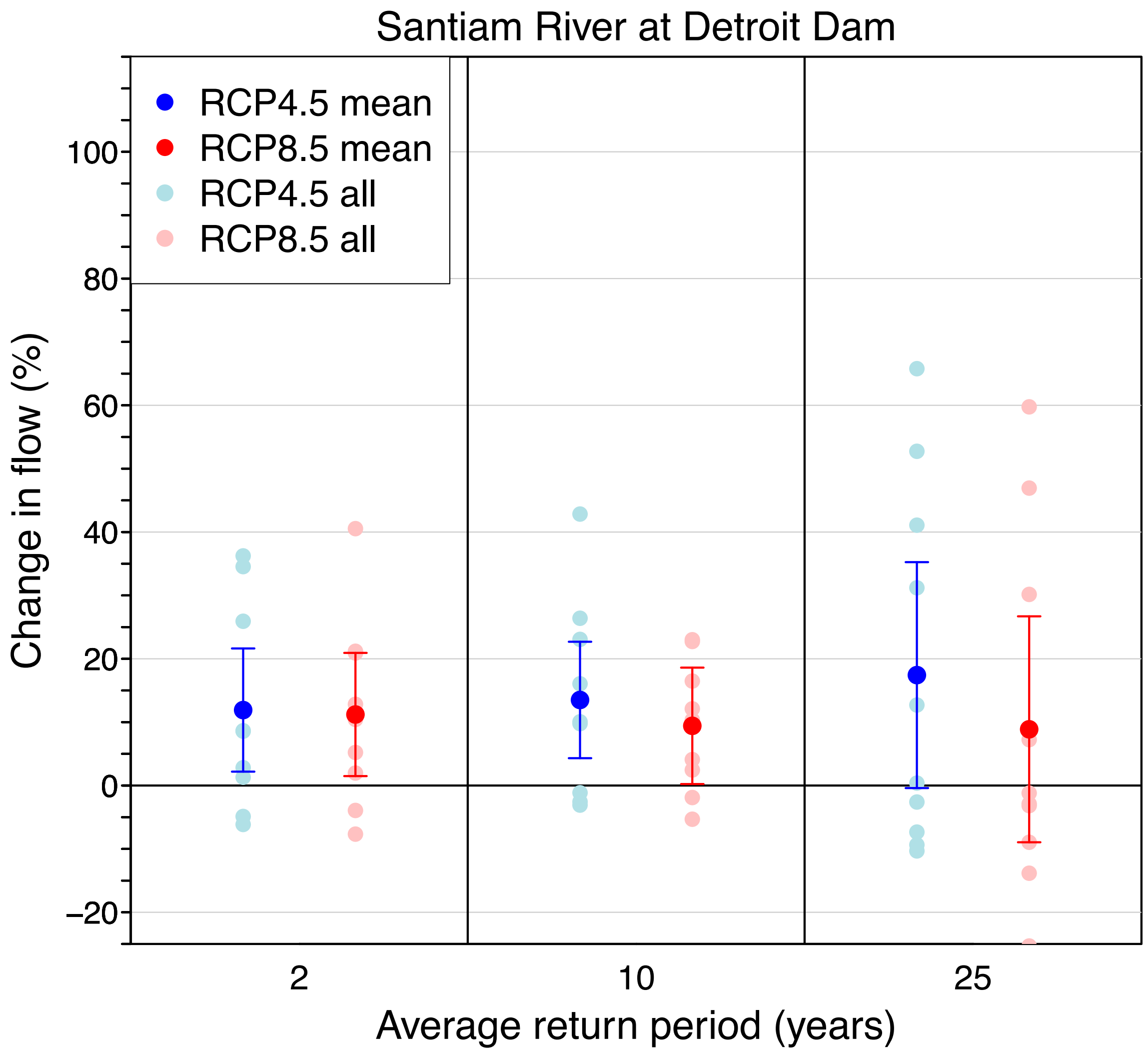

Figure 15. Projected change in water-year maximum daily, non-regulated streamflows with 2-year, 10-year, and 25-year return periods for the Santiam River at Detroit Dam from 1961–2010 to 2031–2080 under lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios. Larger blue and red dots and bars represent the mean and two standard errors across ten global climate models. Only a subset of the full set of 20 models simulated future hydrology (see Appendix). Smaller light blue and light red dots represent individual models. (Data source: Integrated Scenarios of the Future Northwest Environment, https://climate.northwestknowledge.net/IntegratedScenarios/; Figure source: David Rupp, OCCRI)

Table 11. Percent change in peak flow associated with multiple return periods for two locations in Marion County under the higher emissions scenario. The time period of analysis varies among sources.

Return Period (Probability that this level will be exceeded in a given year)	Average Percent Change in Flow	Location	Time Periods	Source
2-year (50%)	10	Willamette River at Salem	2031–2080 vs. 1961–2010	David Rupp
	11	Santiam River at Detroit Dam	2031–2080 vs. 1961–2010	David Rupp
10-year (10%)	37	Willamette River at Salem	2050-2099 vs. 1950-1999	Queen et al. (2021)
	23	Willamette River at Salem	2031–2080 vs. 1961–2010	David Rupp
	9	Santiam River at Detroit Dam	2031–2080 vs. 1961–2010	David Rupp
25-Year (4%)	29	Willamette River at Salem	2031–2080 vs. 1961–2010	David Rupp
	9	Santiam River at Detroit Dam	2031–2080 vs. 1961–2010	David Rupp
100-Year (1%)	43	Willamette River at Salem	2050-2099 vs. 1950-1999	Queen et al. (2021)

Some of the Northwest's highest floods occur when large volumes of warm rain from atmospheric rivers fall on a deep snowpack, resulting in rain-on-snow floods (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 increase the likelihood of flooding (Konrad and Dettinger, 2017).

Future changes in the frequency of rain-on-snow events likely will vary along an elevational gradient. 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). How such changes in frequency of rain-on-snow events are likely to affect streamflow varies. For example, projections for the Santiam River, Oregon, indicate an increase in annual peak daily flows at return intervals less than 10 years, but a decrease in annual peak daily flows at return intervals greater than or equal to 10 years (Surfleet and Tullos, 2013). Average runoff from rain-on-snow events in watersheds in northern coastal Oregon is 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 extreme rainfall that exceeds soil capacity (Berghuijs *et al.*, 2016; Musselman *et al.*, 2018). Shifts in vegetation and wildfire occurrences 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.*, 2020; Williams *et al.*, 2022).

Key Messages

⇒ Winter flood risk at mid- to low elevations in Marion 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 is common in the Northwest. The incidence, extent, and severity of drought has increased over the last 20 years relative to the twentieth century, and this trend is expected to continue under future climate change (Dalton and Fleishman, 2021). Drought can be defined in many ways (Table 12), but most fundamentally is insufficient water to meet needs (Redmond, 2002; Dalton and Fleishman, 2021).

Table 12. Definitions and characteristics of various drought classes. (Source: Dalton and Fleishman, 2021; Fleishman *et al.*, unpublished)

Drought Class	Definition and Characteristics
Meteorological	• lack of precipitation • evaporative demand that exceeds precipitation • minimum period of time for consideration operationally is 90 days
Hydrological	• prolonged meteorological drought affects surface or subsurface water supply, such as streamflow, reservoir and lake levels, or groundwater levels • tends to evolve more slowly than meteorological drought, with extents longer than six months
Agricultural	• occurs when meteorological and hydrological drought impacts agricultural production • reflects precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, and reduced availability of irrigation water
Socioeconomic	• occurs when meteorological, hydrological, or agricultural drought reduces the supply of some economic or social good or service • often affects 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	• relatively short periods of warm surface temperatures, low relative humidities and precipitation deficits, and rapidly declining 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 followed by summers with low river and stream flows • warm snow drought—low snowpack with above average precipitation and temperature • dry snow drought—low snowpack and low precipitation

Summers in Oregon are expected to become warmer and drier, and mountain snowpack is projected to decline due to warmer winter temperatures (Dalton and Fleishman, 2021). Across the western United States, the decline in mountain snowpack is projected to reduce summer soil moisture in the mountains (Gergel *et al.*, 2017). Climate change is expected to result in lower summer streamflows in snow-dominated and mixed rain-and-snow basins across the Northwest as snowpack melts earlier due to warmer temperatures and decreases in summer precipitation (Dalton *et al.*, 2017; Mote *et al.*, 2019). For example, summer flow is projected to decrease in the Willamette River at Salem (Figure 12) and in the Santiam River at Detroit Dam (Figure 13) by the 2050s (2040–2069). As mountain snowpack declines, seasonal drought will become less predictable and snow droughts will increase the likelihood of meteorological and hydrological drought in subsequent seasons (Dalton and Fleishman, 2021).

This report presents projected changes in four variables indicative of drought: low spring snowpack (snow drought), low summer soil moisture from the surface to 55 inches below the surface (agricultural drought), low summer runoff (hydrological drought), and low summer precipitation (meteorological drought). Drought is presented in terms of a change in the probability of exceeding the magnitude of seasonal drought conditions for which the historical annual probability of exceedance was 20% (5-year return period) (Figure 16).

In Marion County, summer (June–August) soil moisture, spring (April 1) snowpack, summer runoff, and summer precipitation are projected to decline by the 2050s under both lower (RCP 4.5) and higher (RCP 8.5) emissions scenarios. Therefore, seasonal drought conditions will occur more frequently by the 2050s under both emissions scenarios (Figure 16). By the 2050s under the higher emissions scenario, the annual probability of low summer soil moisture is projected to be about 47% (2.1-year return period). The annual probability of low spring snowpack and low summer runoff is projected to be about 75% (1.3-year return period). The annual probability of low summer precipitation is projected to be 33% (3.1-year return interval). Drought projections for the 2020s were not evaluated due to data limitations, but drought magnitudes in the 2020s likely will be smaller than those in the 2050s.

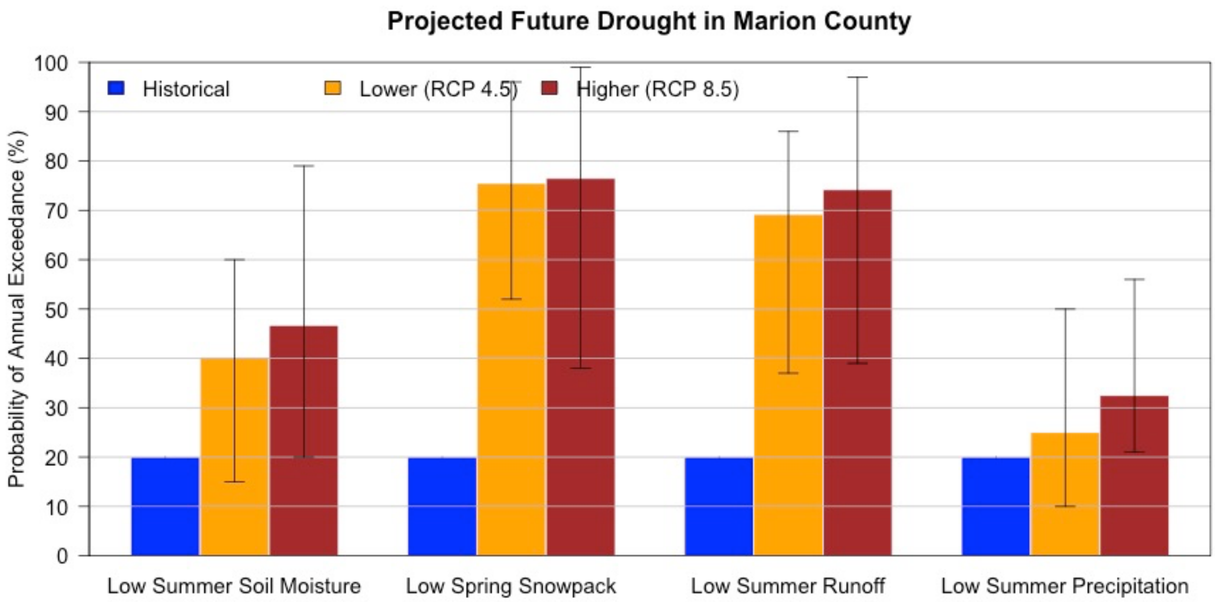

Figure 16. Projected probability of exceeding the magnitude of seasonal drought conditions for which the historical annual probability of exceedance was 20%. Projections are for the 2050s (2040–2069), relative to the historical baseline (1971–2000), under two emissions scenarios. Seasonal drought conditions 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, https://climate.northwestknowledge.net/IntegratedScenarios/)

Key Messages

⇒ Drought, as represented by low summer soil moisture, low spring snowpack, low summer runoff, and low summer precipitation, is projected to become more frequent in Marion County by the 2050s.

Wildfire

Human activities have modified fire dynamics in the western United States through clearance of native vegetation for agriculture and urbanization, fragmentation and exploitation of forests and other natural land-cover types, human population growth and increased recreational activities, introduction of highly flammable, non-native annual grasses, and replacement of indigenous or natural fires by extensive fire suppression and vegetation management. 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 fuels.

Over the last several decades, warmer and drier summers across the western United States have contributed to an increase in vegetation dryness and outbreaks of native insect herbivores contributing to increased dead fuels. Concurrently, the duration of the wildfire season has increased across the region (Dennison *et al.*, 2014; Jolly *et al.*, 2015; Westerling, 2016; Williams and Abatzoglou, 2016), largely due to warmer springs that cause earlier snowmelt and to an overall decline in mountain snowpack, mostly in response to warmer winters (Westerling, 2016).

Vegetation dryness is often caused by dry air. Vapor pressure deficit (VPD) corresponds to the difference in atmospheric pressure between water vapor in the air and the air's saturation point, which is the maximum amount of water the air can carry at its current temperature (dew point). This pressure difference drives transpiration by the plants' stomata. VPD and other measures of atmospheric dryness, such as evaporative demand, are more strongly associated with forest area burned than precipitation, drought indices, or temperature (Sedano and Randerson, 2014; Williams *et al.*, 2014; Seager *et al.*, 2015; Rao *et al.*, 2022). The area of forests burned annually is expected to increase exponentially with projected increases in VPD across the western United States (Zhuang *et al.*, 2021; Juang *et al.*, 2022).

CMIP6 climate model results suggest that human emissions of greenhouse gases can explain a large percentage of the observed VPD increase (Zhuang *et al.*, 2021). In the western United States from 1984 through 2015, about half of the observed increase in vegetation dryness—driven mainly by the dryness of the air—and 4.2 million hectares (16,000 square miles) of burned area were attributable to human-caused climate change (Abatzoglou and Williams, 2016).

Fire danger is generally evaluated on the basis of daytime conditions that may cause wildfires to spread. Historically, wildfires were less active overnight. However, nights have become hotter and drier, and the temperature and duration of wildfires is expected to increase as a result (Balch *et al.*, 2022). In 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).

Vegetation can also amplify or dampen the effect of aridity on wildfires. The geographic co-occurrence of plants with high water sensitivity (e.g., plants that do not close their stomata, shallow-rooted plants on porous soils) and high VPD suggests that the distribution of vegetation in the western United States has amplified the effect of climate change on wildfire hazard (Rao *et al.*, 2022).

High temperatures contribute to the drying of dead vegetation, and high VPD reduces moisture in live vegetation (e.g., the tree canopy), increasing the likelihood that any source of ignition will create a wildfire. The interaction between continued development in areas with flammable vegetation and increases in VPD suggests that projections of changing wildfire risk in the western United States may be conservative (Rao *et al.*, 2022), especially given that over 80% of all ignitions in the United States are now human-caused (Balch *et al.*, 2017) and that human activities have extended both the temporal and geographic extent of the fire season (Balch *et al.*, 2017; Bowman *et al.*, 2020). Furthermore, extreme wildfires may correspond to concurrent weather extremes, including high temperatures, aridity, and wind speeds. Coincidence among these extremes is becoming more common (Abatzoglou *et al.*, 2021a).

In 2020, the Santiam fire (Beachie Creek fire in Marion County) became the poster child of such combination of extreme fire danger conditions unprecedented in the contemporary data record—warm and dry late summer conditions, extremely dry live and dead vegetation, strong and dry east winds—causing widespread loss of structures and sadly also five human lives (Abatzoglou *et al.*, 2021b). Management practices also likely factored in the severity of the fire (Reilly *et al.*, 2017). For example, uniform canopy structure, such as in forest plantations, favors a subcanopy wind regime that transports moisture out of the watershed (Drake *et al.*, 2022). This finding is relevant to forest water use and climate change over large areas of the Pacific Northwest mountainous forest lands.

Projecting wildfire risk across the western United States in response to changes in climate and land use requires understanding the interactions among biology, climate, and human activity. 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). Multiple modeling approaches indicate future increases in forest area burned in the western United States (Abatzoglou *et al.*, 2021a). Similarly, model simulations of a common fire index based on precipitation and temperature, the Keetch–Byram Drought Index, and a proxy for fuel availability suggest that the number of days on which fire risk is extremely high will increase through the end of the twenty-first century (Brown *et al.*, 2021). Overall, wildfire frequency, intensity, and area burned are projected to continue increasing in the Northwest, even in climatologically wet areas in western Oregon (Dalton *et al.*, 2017; Mote *et al.*, 2019; Dalton and Fleishman, 2021)

This report considers the number of days with extreme values of 100-hour fuel moisture (FM100) and VPD as a proxy for wildfire risk. FM100 is a measure of the percentage of moisture in the dry weight of dead vegetation with 1–3 inch diameter, and commonly is used by the Northwest Interagency Coordination Center (https://gacc.nifc.gov/nwcc/) to predict fire danger. A majority of climate models project that fuel moisture will decline across Oregon by the 2050s (2040–2069) under the higher emissions scenario (Gergel *et al.*, 2017). As explained above, drying of vegetation leads to greater wildfire risk, especially when coupled with decreases in summer soil moisture and increases in evaporative demand. CMIP6 model simulations given a higher emissions scenario projected that warm season VPD over the next 30 years will increase at a rate similar to that observed across the western United States from 1980 through 2020 (Zhuang *et al.*, 2021). Increases in VPD also were projected by CMIP5 models to contribute substantially to wildfire risk in Oregon (Ficklin and Novick, 2017; Chiodi *et al.*, 2021). Furthermore, observed increases in nighttime temperatures (Balch *et al.*, 2022) and in nighttime VPD (Chiodi *et al.*, 2021) have been linked to fires burning longer into the night and increasing in intensity much earlier in the morning, which reduces the window of opportunity for suppression.

In this report, the future change in wildfire risk is expressed as the increase in the average annual number of days on which fire danger is very high and VPD is extreme. Projections are presented for two future periods under two emissions scenarios compared to the historical baseline. A day on which fire danger is very high is defined as a day on which FM100 is lower (i.e., vegetation is drier) than the historical 10th percentile value. Historically, fire danger was very high on 36.5 days per year. A day on which VPD is extreme is defined as a day on which VPD exceeds the historical warm season (March–November) 90th percentile value.

In Marion County, the average number of days per year on which fire danger is very high is projected to increase by 13 days (range -6–32) by the 2050s, compared to the historical baseline, under the higher emissions scenario (Figure 17). The average number of days per year on which VPD is extreme is projected to increase by 27 days (range 9–43) by the 2050s, compared to the historical baseline, under the higher emissions scenario (Figure 18). The impacts of wildfire on air quality are discussed in the following section, Reduced Air Quality.

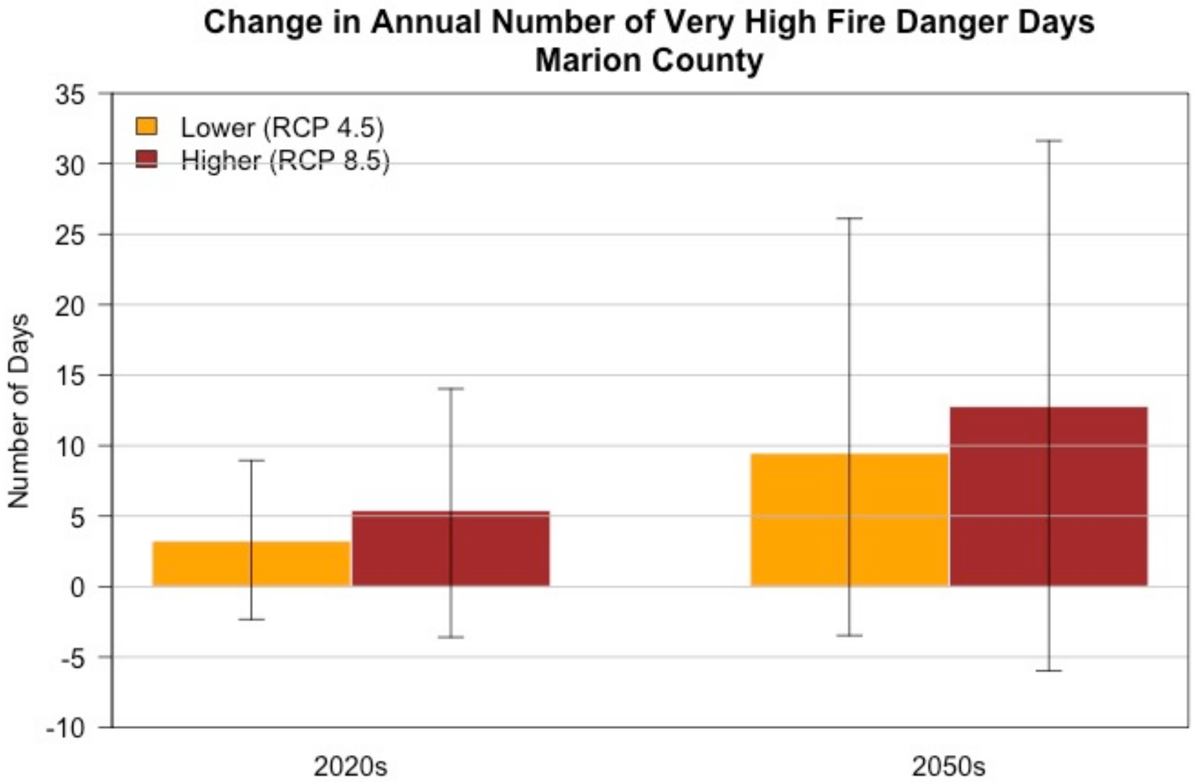

Figure 17. Projected changes by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the 1971–2000 historical baseline and under two emissions scenarios, in the number of days on which fire danger in Marion County is very high. Changes were calculated for each of 18 global climate models relative to each model's historical baseline, then averaged across the 18 models. Whiskers represent the range of changes across 18 models. Only 18 of the 20 models had the necessary data available to compute fire danger. (Data Source: Climate Toolbox, climatetoolbox.org/tool/Climate-Mapper)

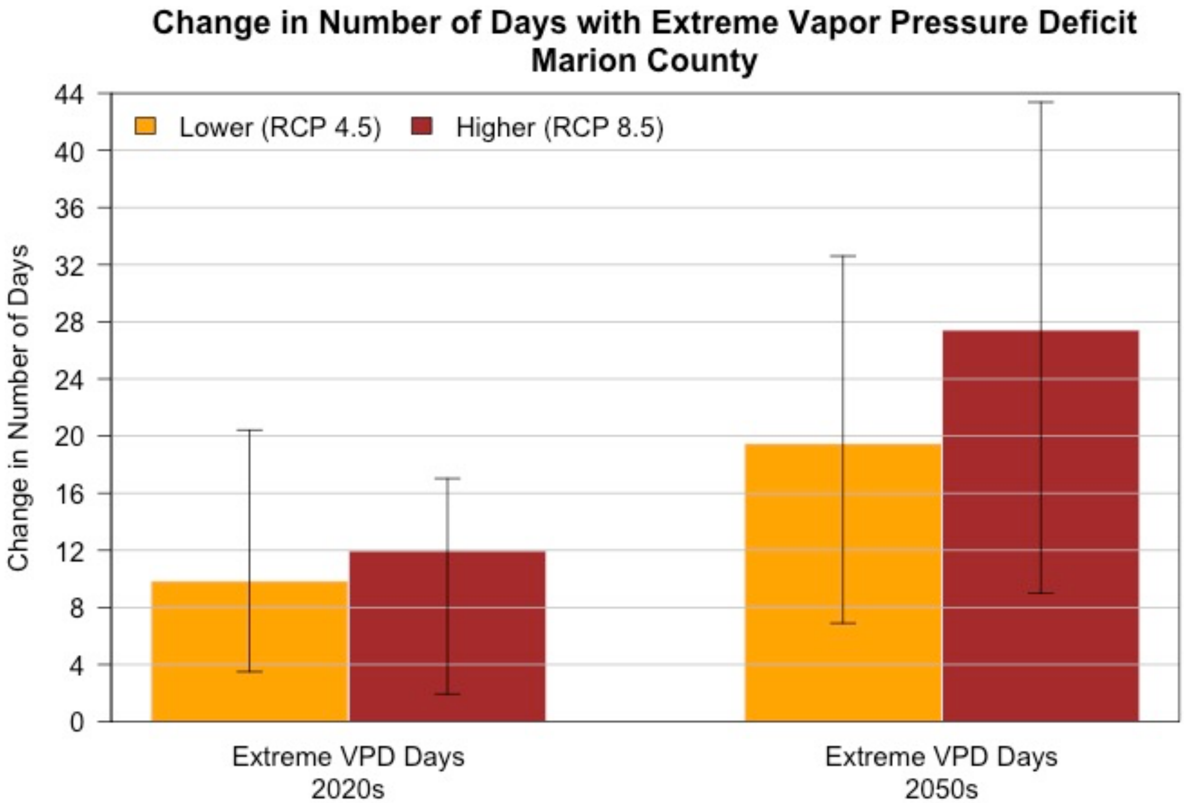

Figure 18. Projected changes by the 2020s (2010–2039 average) and 2050s (2040–2069 average), relative to the 1971–2000 historical baseline and under two emissions scenarios, in the number of days on which vapor pressure deficit in Marion County is extreme. Changes were calculated for each of 20 global climate models relative to each model's historical baseline, then averaged across the 20 models. Whiskers represent the range of changes across 20 models. (Data Source: Climate Toolbox, climatetoolbox.org/tool/Climate-Mapper)

Key Messages

⇒ Wildfire risk, expressed as the average number of days per year on which fire danger is very high, is projected to increase in Marion County by 13 days (range -6–32) by the 2050s, relative to the historical baseline, under the higher emissions scenario.

⇒ In Marion County, the average number of days per year on which vapor pressure deficit is extreme is projected to increase by 27 days (range 9–43) by the 2050s, compared to the historical baseline, under the higher emissions scenario.

Reduced Air Quality

Climate change is expected to 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 fine 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).

Over the past several decades, fire seasons have increased in length, and the intensity and severity of wildfires have increased. This trend is expected to continue as a result of complex factors including traditional forest management practices, increasing population density in fire risk zones, and climate change (Sheehan *et al.*, 2015). Large wildfires in the western United States created extensive smoke plumes that traveled at high altitudes over long distances and affected air quality not only near to but far from those wildfires. Hazardous levels of air pollution are most common near wildfires. Fires emit fine particulate matter (less than 2.5 micrometers in diameter [$PM_{2.5}$]), which exacerbate 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). Wildfire smoke also impairs visibility and can disrupt outdoor recreational and social activities, in turn affecting physical and mental health (Nolte *et al.*, 2018).

From 2000 through 2020, the frequency, duration, and area of co-occurrence of two air pollutants related to wildfire smoke, $PM_{2.5}$ and ozone, increased in the western United States (Kalashnikov *et al.*, 2022) and the Pacific Northwest in particular (Buchholz *et al.*, 2022). Wildfires emit ozone precursors that in hot and sunny conditions react with other pollutants to increase the concentration of ozone. The area in which $PM_{2.5}$ and ozone co-occurred more than doubled during the past 20 years.

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), although woodstove smoke and diesel emissions also contribute (Oregon DEQ, 2016). Fine particulate matter from vehicles, woodstoves, and power plants can be regulated, but it is much more difficult to control wildfires. Therefore, increasingly chronic smoke exposure that has potentially severe health consequences (Liu *et al.*, 2016). 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 medium emissions scenario (SRES A1B) (Liu *et al.*, 2016). The SRES A1B scenario, which is from an earlier generation of emissions scenarios, is most similar to RCP 6.0 (Figure 2). CMIP6 models integrated with an empirical statistical model projected that $PM_{2.5}$ concentrations in August and September in the Northwest will double to triple by 2080–2100 under lower (SSP5-4.5) and higher (SSP5-8.5) emissions scenarios (Xie *et al.*, 2022).

This report presents 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. Mean number of smoke wave days and mean smoke wave intensity are projected for two six-year periods, 2004–2009 and 2046–2051, under a medium emissions scenario. More information about these methods of projecting future air quality is in the Appendix. In Marion County, the number of smoke wave days is projected to increase by 18% and the intensity of smoke wave days is projected to increase by 91% (Figure 19).

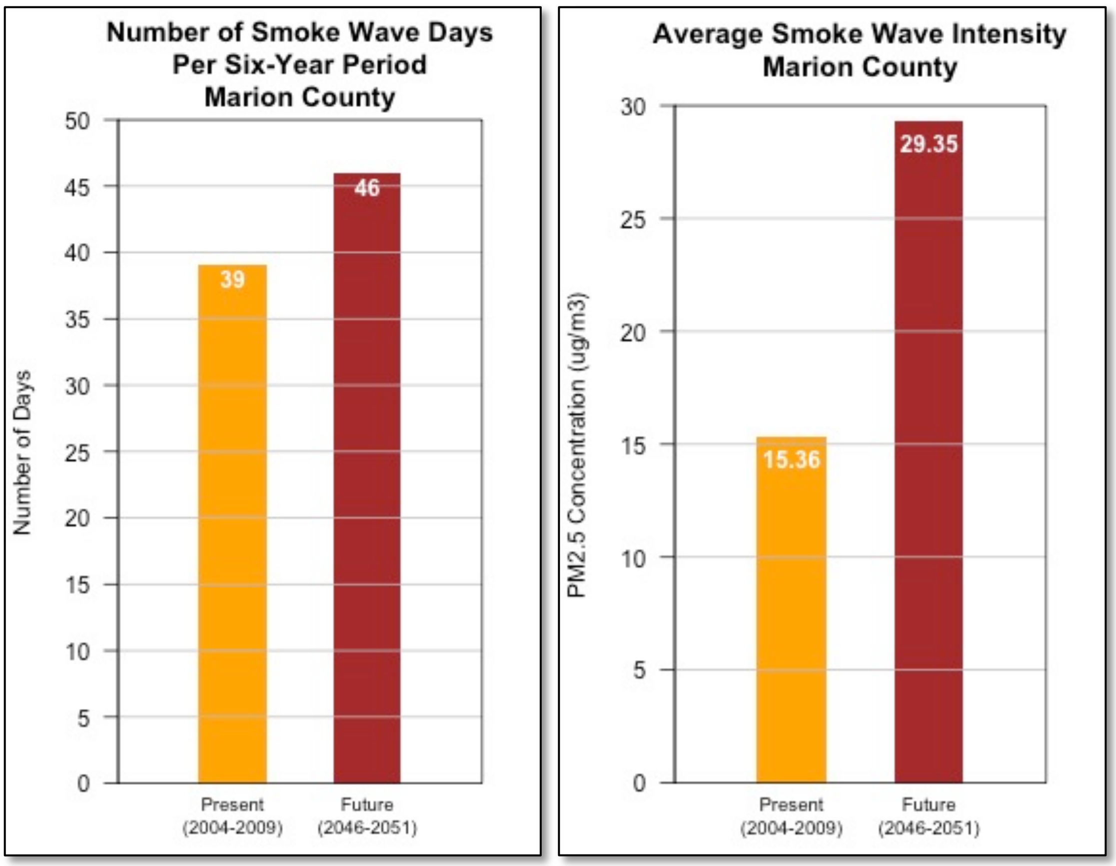

Figure 19. Simulated present (2004–2009) and future (2046–2051) number (left) and intensity (right) of smoke wave days in Marion County under a medium emissions scenario. Values represent the mean among 15 global climate models. (Data source: Liu et al. 2016, https://khanotations.github.io/smoke-map/)

Plants also are responding to changes in climate and atmospheric concentrations of carbon dioxide by producing more pollen, and by producing pollen earlier in spring and for longer periods of time (Ziska *et al.*, 2009). From 1990 through 2018, 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 also could become more abundant following extreme floods or droughts, which are expected to become more common with climate change. 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 particulates 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).

Key Messages

⇒ The risk of wildfire smoke in Marion County is projected to increase. The number of days per year on which the concentration of wildfire-derived fine particulate matter results in poor air quality is projected to increase by 19%, and the concentration of fine particulate matter is projected to increase by 91%, from 2004–2009 to 2046–2051 under a medium emissions scenario.

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 class) 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). 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 species depends on seasonal flooding (Dwire *et al.*, 2018). Systems 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 demand for ground water, decreases in ground water availability may affect wetlands. 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 or decreases in water availability increase use of wetlands by domestic livestock, habitat quality for native species likely will decrease.

Key Messages

⇒ In Marion 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.

Windstorms

Climate change has the potential to alter surface winds through changes in the global free atmospheric circulation and storm systems, and through changes in the connection between the free atmosphere and Earth's surface. West of the Cascade Range, changes in surface wind speeds tend to follow changes in upper atmosphere winds associated with extratropical cyclones (Salathé *et al.*, 2015). The trend in winter extratropical storm frequency in the northeast Pacific since 1950 was positive, although not statistically significant (Vose *et al.*, 2014). However, uncertainty in projections of future extratropical cyclone frequency is high (IPCC, 2013).

Future projections indicate a slight northward shift in the jet stream and extratropical cyclone activity in the North Pacific. Over the Northern Hemisphere, the frequency of the most intense extratropical cyclones generally is projected to decrease, although in the northern North Pacific the frequency is projected to increase (IPCC, 2021) Therefore, there is no consensus on whether extratropical storms (Vose *et al.*, 2014; Seiler and Zwiers, 2016; Chang, 2018) and associated extreme winds (Kumar *et al.*, 2015) will intensify or become more frequent along the Northwest coast under a warmer climate.

Key Messages

⇒ Limited research suggests little if any change in the frequency and intensity of windstorms in the Northwest as a result of climate change.

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 plants and animals that are considered to be invasive or pests in natural and agricultural systems. Increasing concentrations of carbon dioxide not only lead to increases in global temperature, but 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). Changes in climate, ongoing human additions of nitrogen to the environment, and their interactions also affect the growth and competitive relations among plant and animal species (Greaver *et al.*, 2016). In general, invasive and pest species in Marion County are likely to become more prevalent in response to projected increases in temperature. However, many of these responses are uncertain, and are likely to vary locally. Moreover, the responses may change over time.

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, especially when organisms have 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 plants or animals generally are more susceptible to pests and pathogens than individuals in areas with higher species richness or populations with greater demographic diversity.

The Marion County Weed District's Weed List classifies nine species as subjects for education and control: false brome (*Brachypodium sylvaticum*); giant, Japanese, and Himalayan or Bohemian knotweed (*Polygonum sachalinensis*, *Fallopia japonica*, *Fallopia X bohemica*); meadow and spotted knapweed (*Centaurea debeauxii*, *C. stoebe*); milk thistle (*Silybum marianum*); puncture vine (*Tribulus terrestris*); purple loosestrife (*Lythrum salicaria*), tansy ragwort (*Jacobaea vulgaris*); yellow flag iris (*Iris pseudacorus*); and yellow toadflax (*Linaria vulgaris*). These taxa occur in the county, and in some locations are abundant. An additional 11 taxa are classified as immediate action or eradicate: common gorse (*Ulex europaeus*), diffuse knapweed (*Centaurea diffusa*), garlic mustard (*Alliaria petiolata*), giant hogweed (*Heracleum mantegazzianum*), Italian thistle (*Carduus pycnocephalus*), kochia (*Kochia scoparia*), oblong spurge (*Euphorbia oblongata*), Paterson's curse (*Echium plantagineum*), rush skeletonweed (*Chondrilla juncea*), traveler's joy

(*Clematis vitalba*), and yellow starthistle (*Centaurea solstitialis*). Although little is known about how several of these species may to respond to climate change, some evidence suggests how others may be affected.

Responses of invasive plants to increases in temperature are diverse, even within the same species. For example, photosynthesis in Japanese knotweed, a shrub, currently 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), and the species may continue to become more widespread or abundant as minimum temperatures increase. In England, giant hogweed, a perennial forb, germinated earlier as the number of heat degree days >41˚F increased, and the species' overwinter survival decreased as frost incidence increased, but overwinter survival of seeds was not related to winter temperature or the number of days with frost from November through March (Willis and Hulme, 2002).

Warming increased seed mass of diffuse knapweed, a biennial or short-lived perennial forb, independent of increases in carbon dioxide (Li *et al.*, 2018). Garlic mustard, a biennial forb, flowered about 3.1 days earlier per ˚F increase in temperature in the United Kingdom (Fox and Jönsson, 2019). Increases in mean monthly temperature and maximum daily temperature, and reduction in the number of spring days with minimum temperatures below 32˚F, may lead to earlier seedling emergence and increase reproduction and recruitment of garlic mustard (Blossey *et al.*, 2017; Anderson *et al.*, 2021). Nevertheless, germination of garlic mustard seeds currently requires winter chilling, and increases in winter temperature may limit the species' expansion until it evolves tolerance of higher winter temperatures (Footitt *et al.*, 2018). By contrast, reproduction of false brome, a perennial bunchgrass, along a latitudinal gradient in Europe was independent of temperature (growing degree hours above 41˚F after 1 January) (De Frenne *et al.*, 2009).

Purple loosestrife, a perennial forb, readily colonizes wetlands. Its flowering phenology 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, 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).

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. The competitive advantage of non-native forbs and grasses over native taxa may be strongest in relatively warm and dry microclimates, 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, the size of yellow starthistle, an annual forb, increased substantially in response to experimentally increased carbon dioxide and, primarily in relatively warm areas, to nitrogen deposition, whereas co-occurring native plants responded less strongly (Dukes *et al.*, 2011). Similarly, Japanese knotweed may gain a competitive advantage over native species when nitrogen availability is variable or episodic (Parepa *et al.*, 2013). However, 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).

Changes in the amount and timing of precipitation may contribute to expansion or contraction of different non-native invasive plants. Some invasives in Marion County, such as kochia, an annual forb, have high drought tolerance. Normal to high precipitation can decrease the viability of certain invasive plants, at least in some contexts. For example, common gorse, an evergreen shrub, can spread after wildfire and generally is highly flammable. However, extreme precipitation following wildfire directly or indirectly may reduce seedling survival via movement of soil and litter, which can either expose or bury the small plants (Luís *et al.*, 2005). 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).

Spotted knapweed, a perennial forb, 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 the species appear to be less affected by drought (Pearson *et al.*, 2017). Similarly, reduction in total precipitation and number of days with precipitation may decrease reproduction and recruitment of garlic mustard, whereas decreases in the number of continuous days without precipitation may increase reproduction and recruitment (Anderson *et al.*, 2021).

Evidence that drought limits vegetative growth of purple loosestrife is equivocal. 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).

Key Messages

⇒ In general, non-native invasive plants in Marion 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

Future Climate Projections Background

Read more about global climate models, emissions scenarios, and uncertainty in the Climate Science Special Report—Volume 1 of the Fourth National Climate Assessment (https://science2017.globalchange.gov).

Global climate models (GCMs) and downscaling: https://science2017.globalchange.gov/chapter/4#section-3

Emissions scenarios: https://science2017.globalchange.gov/chapter/4#section-2

Uncertainty: https://science2017.globalchange.gov/chapter/4#section-4

Coupled Model Intercomparison Project phase 6 (CMIP6) climate models and emissions scenarios: see section B. Possible Climate Futures, https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf.

Climate and Hydrological Data

Statistically downscaled GCM outputs from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) were the basis for projections of future temperature, precipitation, and hydrology in this report. The coarse resolution of the GCMs outputs (100–300 km) was 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). The MACA approach uses gridded observational data to train the downscaling. It applies bias corrections and matches the spatial patterns of observed coarse-resolution to fine-resolution statistical relations. For a detailed description of the MACA method see https://climate.northwestknowledge.net/MACA/MACAmethod.php.

MACA data are the inputs to integrated models of climate, hydrology, and vegetation run by the Integrated Scenarios of the Future Northwest Environment project (https://climate.northwestknowledge.net/IntegratedScenarios/). Snow dynamics were simulated by the Integrated Scenarios project, which applied the Variable Infiltration Capacity hydrological model (VIC version 4.1.2.l; Liang *et al.*, 1994 and updates) to a 1/16 x 1/16 degree (6 km) grid.

Simulations of daily maximum temperature, minimum temperature, and precipitation from 1950 through 2099 for 20 GCMs (Table 13) and two emissions scenarios (RCP 4.5 and RCP 8.5) are available. Hydrological simulations of snow water equivalent (SWE) are available for the 10 GCMs used as input to VIC. All available modeled outputs were obtained from the Integrated Scenarios data archives and included in this report to represent the mean and range of projections among the largest possible ensemble of GCMs.

Table 13. The 20 CMIP5 GCMs represented in this report. Asterisks indicate the ten GCMs used as inputs to the Variable Infiltration Capacity hydrological model.

Model Name	Modeling Center
BCC-CSM1-1 BCC-CSM1-1-M*	Beijing Climate Center, China Meteorological Administration
BNU-ESM	College of Global Change and Earth System Science, Beijing Normal University, China
CanESM2*	Canadian Centre for Climate Modeling and Analysis
CCSM4*	National Center for Atmospheric Research, USA
CNRM-CM5*	National Centre of Meteorological Research, France
CSIRO-Mk3-6-0*	Commonwealth Scientific and Industrial Research Organization/Queensland Climate Change Centre of Excellence, Australia
GFDL-ESM2G GFDL-ESM2M	NOAA Geophysical Fluid Dynamics Laboratory, USA
HadGEM2-CC* HadGEM2-ES*	Met Office Hadley Center, UK
INMCM4	Institute for Numerical Mathematics, Russia
IPSL-CM5A-LR IPSL-CM5A-MR* IPSL-CM5B-LR	Institut Pierre Simon Laplace, France
MIROC5* MIROC-ESM MIROC-ESM-CHEM	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies, Japan
MRI-CGCM3	Meteorological Research Institute, Japan
NorESM1-M*	Norwegian Climate Center, Norway

All simulated climate data and the streamflow data, with the exception of snow water equivalent, were bias-corrected with quantile mapping by the Integrated Scenarios project. Quantile mapping adjusts simulated values by comparing the cumulative probability distributions of simulated and observed values. In practice, the simulated and observed values of a variable (e.g., daily streamflow) 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 data reflect quantile mapping relations for each non-overlapping 15-day window in the calendar year. Streamflow data reflect quantile mapping relations for each calendar month.

The Integrated Scenarios project simulated hydrology with VIC (Liang *et al.*, 1994) run on a 1/16 x 1/16 degree (6 km) grid. To generate daily streamflow estimates, daily runoff from VIC grid cells was routed to selected locations along the stream network. Where records of naturalized flow were available, the daily streamflow estimates were bias-corrected so their statistical distributions matched those of the naturalized streamflows.

Vapor pressure deficit and 100-hour fuel moisture were computed by the Integrated Scenarios project with the same MACA climate variables according to the equations in the National Fire Danger Rating System (NWCG, 2019).

Smoke Wave Data

Data from Liu et al. (2016) are available at https://khanotations.github.io/smoke-map/. Variables used in this report included “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 each 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 medium 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 I:
LIST OF ACRONYMS

Oregon

AGC	Associated General Contractors
AOC	Association of Oregon Counties
BCD	Building Codes Division (Department of Consumer and Business Services)
BPA	Bonneville Power Administration
CPW	Community Planning Workshop (University of Oregon)
DAS	Department of Administrative Services
DCBS	Department of Consumer and Business Services
DEQ	Department of Environmental Quality
DHS	Department of Human Services
DLCD	Department of Land Conservation and Development
DOE	Department of Energy
DOGAMI	Department of Geology and Mineral Industries
DSL	Division of State Lands
ESD	Education Service District
IHMT	Interagency Hazard Mitigation Team
METCOM	Marion Area Multi-Agency Emergency Telecommunications Dispatch Center
MWVCOG	Mid-Willamette Valley Council of Governments
NRO	Natural Resources Office
LCDC	Land Conservation and Development Commission (State of Oregon)
LOC	League of Oregon Cities
OAR	Oregon Administrative Rules
OCCRI	Oregon Climate Change Research Institute
OCS	Oregon Climate Service

ODA	Oregon Department of Agriculture
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OEM	Oregon Department of Emergency Management
OEMA	Oregon Emergency Management Association
OERS	Oregon Emergency Response System
OHCS	Oregon Housing and Community Services
OHIRA	Oregon Hazard Identification and Risk Assessment
OPDR	Oregon Partnership for Disaster Resilience
ORS	Oregon Revised Statues
OSFM	Office of State Fire Marshal
OSP	Oregon State Police
OSSPAC	Oregon Seismic Safety Policy Advisory Commission
OSU	Oregon State University
OWEB	Oregon Watershed Enhancement Board PSU Portland State University
UO-IPRE	University of Oregon – Institute for Policy Research and Engagement
PUC	Public Utility Commission
SEAO	Structural Engineers Association of Oregon
SHMO	State Hazard Mitigation Officer
UGB	Urban Growth Boundary
WRD	Water Resources Department
WVCC	Willamette Valley Communication Center

Federal

AASHTO	American Association of State Highway and Transportation Officials
ATC	Applied Technology Council
b/ca	benefit/cost analysis
BFE	Base Flood Elevation

BLM	Bureau of Land Management
BRIC	Building Resilient Infrastructure and Communities Program
BSSC	Building Seismic Safety Council
CDBG	Community Development Block Grant Programs (HUD Program)
CFR	Code of Federal Regulations
CRS	Community Rating System
CVO	Cascade Volcano Observatory (USGS)
EDA	Economic Development Administration
EIA	Energy Information Administration (U.S.)
EPA	Environmental Protection Agency
ER	Emergency Relief
EWP	Emergency Watershed Protection (NRCS Program)
FAS	Federal Aid System
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance (FEMA Program)
FMAG	Fire Management Assistance Grant Program
FTE	Full Time Equivalent
GIS	Geographic Information System
GNS	Institute of Geological and Nuclear Sciences (International)
GSA	General Services Administration
HAZUS	Hazards U.S. (HAZUS-MH is Hazards U.S. – Multi-Hazard)
HMGP	Hazard Mitigation Grant Program
HMST	Hazard Mitigation Survey Team
HUD	Housing and Urban Development (U.S. Department of)
IBHS	Institute of Business and Home Safety
ICC	Increased Cost of Compliance
IPCC	Intergovernmental Panel on Climate Change (United Nations)
NCDC	National Climate Data Center

NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NHMP	Natural Hazard Mitigation Plan (also known as “409 plan”)
NIBS	National Institute of Building Sciences
NIFC	National Interagency Fire Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Services
NWS	National Weather Service
PA	Public Assistance Grant Program
RHHPD	Rehabilitation of High Hazard Potential Dam Grant Program
SBA	Small Business Administration
SEDS	State Energy Data System
STORM	Safeguarding Tomorrow through Ongoing Risk Mitigation Revolving Loan Fund
TDR	Transfer of Development Rights
URM	Unreinforced Masonry
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFA	United States Fire Administration
USGS	United States Geological Survey
WSSPC	Western States Seismic Policy Council

APPENDIX J: REFERENCES

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Appendix K:
Federal Emergency Management Agency Review Tool

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 the Local Mitigation Planning Policy Guide. Definitions of the terms and phrases used in the PRT can be found in Appendix E of that Guide.

Plan Information	
Jurisdiction(s)	City of Salem
Title of Plan	City of Salem Natural Hazards Mitigation Plan
New Plan or Update	Update
Single- or Multi-Jurisdiction	Single-jurisdiction
Date of Plan	10/30/2023
Local Point of Contact	
Title	Brian Carrara, Deputy Chief of Administrative Services
Agency	City of Salem Fire Department
Address	370 Trade Street, S.E., Salem, OR 97301
Phone Number	503-588-6153
Email	bcarrara@cityofsalem.net

Additional Point of Contact	
Title	Cynthia Smidt, Natural Hazards Planner
Agency	Oregon Department of Land Conservation and Development
Address	635 Capitol Street NE, Suite 150, Salem, OR 97301-2540
Phone Number	503-804-0902
Email	cynthia.smidt@dlcd.oregon.gov

Review Information	
State Review	
State Reviewer(s) and Title	Jason Gately, Mitigation Planner
State Review Date	8/21/2023
FEMA Review	
FEMA Reviewer(s) and Title	Carrie Martin, CERC Planner Erin Cooper, Mitigation Planning Section Chief
Date Received in FEMA Region	8/24/2023, 10/19/2023
Plan Not Approved	Click or tap to enter a date.
Plan Approvable Pending Adoption	11/9/2023
Plan Approved	12/5/2023

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	City of Salem, OR	Y	Y	Y	Y	Y	Y	n/a	n/a
2									n/a
3									n/a
4									n/a
5									n/a
6									n/a
7									n/a
8									n/a
9									n/a
10									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 the *Local Mitigation Planning Policy 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?	Acknowledgements; Vol. I, Section 1 (pg. 3); Vol. II, Appendix B;	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?	Acknowledgements; Vol. I, Section 1 (pg. 3); Vol. II, Appendix B (all)	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?	Acknowledgements; Vol. I, Section 4, Plan Implementation and Maintenance; Vol. II, Appendix B (all);	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. II, Appendix B (all, including Table B-3 and Table B-4)	Met

Element A Requirements	Location in Plan (section and/or page number)	Met / Not 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. I, Section 2, Hazard Identification and Assessment (all, including FEMA flood zones shown on pg. 79-80); Vol. I, Section 3, Integration; Mitigation Activities and Resources; Vol. I, Section 4, Implementation through Existing Programs (including Table 28); Vol. II, Appendix C, Political Capacity (including Table C-23); Vol. II, Appendix J, References;	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. I, Section 2, Hazard Identification and Assessment (all, including pg. 9, 11, 16-24; 30-36; 43-53; 61-63; 67-80; 106-111; 115-123; 130-135; 143-149; 156-160; 164-168); Vol. I, Section 2, Community Vulnerability Identification and Assessment;	Met
B1-b. Does the plan include information on the location of each identified hazard?	Vol. I, Section 2, Hazard Identification and Assessment (all, including pg. 17; 24; 33; 45-51; 61-62; 69-70; 73-77; 79-80; 108-110; 119-121, 128; 130-135; 144-146; 148; 159; 165-167); Vol. I, Section 2, Community Vulnerability Identification and Assessment; Vol. II, Appendix G;	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?	Vol. I, Section 2, Hazard Identification and Assessment (all, including pg. 20-23; 33-36; 45-53; 62-63; 69-70; 73-77; 79-80; 107-111; 134-135; 146-148; 159-160; 166-168); Vol. I, Section 2, Community Vulnerability Identification and Assessment (all); Vol. II, Appendix G;	Met
B1-d. Does the plan include the history of previous hazard events for each identified hazard?	Vol. I, Section 2, Hazard Identification and Assessment (pg. 13-15; 23-24; 36-38; 53-55; 63-64; 80-83; 111-112; 123-127; 136-138; 150-153; 160-161; 168-170);	Met
B1-e. Does the plan include the probability of future events for each identified hazard? Does the plan describe the effects of future conditions, including climate change (e.g., long-term weather patterns, average temperature and sea levels), on the type, location and range of anticipated intensities of identified hazards?	Vol. I, Section 2, Hazard Identification and Assessment (pg.12, 24-26; 38-39; 55-56; 64-65; 83-84; 112-113; 127; 139-140; 153; 161-162; 170-171); Vol. I, Section 2, Community Vulnerability Identification and Assessment (all); Vol. II, Appendix H;	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. I, Section 2, Risk Assessment	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 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?	Vol. I, Section 2, Hazard Identification (all, including pg. 26-29; 39-42; 56-60; 65-66; 84-96; 113-114; 127-129; 140-142; 154-155; 162-161; 171-172); Vol. I, Section 2, Community Vulnerability Identification and Assessment (all); Vol. II, Appendix G, Appendix H;	Met
B2-b. For each participating jurisdiction, does the plan describe the potential impacts of each of the identified hazards on each participating jurisdiction?	Vol. I, Section 2, Hazard Identification (all, including pg. 26-29; 39-42; 56-60; 65-66; 84-96; 113-114; 127-129; 140-142; 154-155; 162-161; 171-172); Vol. I, Section 2, Community Vulnerability Identification and Assessment (all); Vol. II, Appendix G, Appendix H;	Met
B2-c. Does the plan address NFIP-insured structures within each jurisdiction that have been repetitively damaged by floods?	Vol. I, Section 2, Hazard Identification, Flood Hazard;	Met

ELEMENT B REQUIRED REVISIONS
Required Revision: Click or tap here to enter text.

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?	Vol. I, Section 3, Integration (including pg. 224-256); Mitigation Actions; Mitigation Activities and Resources; Vol. I, Section 4, Implementation through Existing Programs (including pg. 259-261); Vol. II, Appendix A; Appendix B; Appendix E	Met
C1-b. Does the plan describe each participant's ability to expand and improve the identified capabilities to achieve mitigation?	Vol. I, Section 3, Integration; Mitigation Actions; Mitigation Activities and Resources; Vol. I, Section 4, Implementation through Existing Programs; Vol. II, Appendix A; Appendix B;	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?	Vol. I, Section 3, Hazard Identification, Flood Hazard (including pg. 97-99); Vol. 1, Section 3, Mitigation Strategy, Integration	Met

Element C Requirements	Location in Plan (section and/or page number)	Met / Not 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?	Vol. I, Section 3, Mitigation Strategy (including pg. 208-209)	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?	Vol. I, Section 3, Mitigation Strategy (including pg. 215-219); Vol. II, Appendix A	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?	Vol. I, Section 3, Mitigation Strategy (including pg. 215-219); Vol. II, Appendix A	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?	Vol. I, Section 3, Mitigation Actions; Vo. I, Section 4, Project Prioritization Process (pg. 262-264); Vol. II, Appendix D;	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?	Vol. I, Section 2, Hazard Identification, Flood Hazard; Vol. II, Appendix A	Met

ELEMENT C REQUIRED REVISIONS
Required Revision: Click or tap here to enter text.

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?	Vol. I, Section 4, Continued Public Involvement and Participation (pg. 264-265); Vol. II, Appendix B;	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?	Vol. I, Section 4, Plan Maintenance (pg. 261-262);	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.	Vol. I, Section 4, Plan Maintenance (pg. 261-262);	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?	Vol. I, Section 4, Plan Implementation and Maintenance (all, including pg. 261-266);	Met

Element D Requirements	Location in Plan (section and/or page number)	Met / Not 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?	Vol. I, Section 3, Integration; Mitigation Actions; Mitigation Activities and Resources; Vol. I, Section 4, Implementation through Existing Programs (pg. 259-261); Vol. II, Appendix A; Appendix B;	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?	Vol. I, Section 3, Integration; Mitigation Actions; Mitigation Activities and Resources; Vol. I, Section 4, Implementation through Existing Programs (pg. 259-261); Vol. II, Appendix A; Appendix B;	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?	n/a	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?	Vol. I, Section 2, Hazard Identification and Assessment (all, including pg. 26-29; 39-42; 56-60; 65-66; 84-96; 113-114; 127-129; 140-142; 154-155; 162-161; 171-172); Vol. I, Section 2, Community Vulnerability Identification and Assessment (all); Vol. II, Appendix B, Built Environment Capacity, Changes in Development;	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?	Vol. I, Section 2, Hazard Identification and Assessment (all); Vol. I, Section 3, Mitigation Strategy (all); Vol. II, Appendix A; Appendix B	Met
E2-b. Does the plan include a status update for all mitigation actions identified in the previous mitigation plan?	Vol. I, Section 3, Mitigation Actions (pg. 220-223); Vol. II, Appendix A; Appendix B;	Met

Element E Requirements	Location in Plan (section and/or page number)	Met / Not Met
E2-c. Does the plan describe how jurisdictions integrated the mitigation plan, when appropriate, into other planning mechanisms?	Vol. I, Section 3, Integration (pg. 224-256); Mitigation Actions; Mitigation Activities and Resources; Vol. I, Section 4, Implementation through Existing Programs (pg. 259-261); Vol. II, Appendix A; Appendix B;	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?	Adoption resolution received separately	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?	n/a	Choose an item.

ELEMENT F REQUIRED REVISIONS
Comment: **F1-a.** Add the adoption resolution once received to page iv.

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?	n/a	Choose an item.
HHPD1-b. Does the plan incorporate information shared by the state and/or local dam owners?	n/a	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?	n/a	Choose an item.
HHPD2-b. Does the plan document the limitations and describe how to address deficiencies?	n/a	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?	n/a	Choose an item.
HHPD3-b. Does the plan link proposed actions to reducing long-term vulnerabilities that are consistent with its goals?	n/a	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?	n/a	Choose an item.
HHPD4-b. Does the plan describe the criteria used to prioritize actions related to HHPDs?	n/a	Choose an item.

HHPD Requirements	Location in Plan (section and/or page number)	Met / Not Met
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?	n/a	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.		
The State of Oregon imposes no additional requirements upon local NHMPs	n/a	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 Salem NHMP Steering Committee includes a wide range of stakeholders outside of traditional partners. They include academia (Chemeketa Community College and Willamette University); representatives from major employers that sustain community lifelines (Cherriots and Portland General Electric); and representatives of nonprofits that work directly with and provide support to underserved communities and socially vulnerable populations (Mano a Mano; Mid-Willamette Valley Community Action; the ARCHES Project; the Red Cross; the Salem Leadership Foundation; and Church at the Park).
- The team created a Draft Risk Assessment flyer in both English and Spanish. This makes the findings of the Risk Assessment accessible to Spanish-speaking community members.
- Table B-4 lists resolution for all public comments.

Opportunities for Improvement

- On page 3, “IGAs” is assumed to mean “Intergovernmental Agreements.” It is recommended to include the full name the first time you use an acronym.
- When referencing the FEMA flood zones in the Flood section of the Risk Assessment, it may be useful to refer to the map numbers and the effective dates of the FIRMs in the city. You can find this information at www.msc.fema.gov.

Element B. Risk Assessment

Strengths

- The Risk Assessment integrates other planning documents for the city of Salem, its county and region very well. The connection to the effects of climate change is especially strong. The summary of key findings from the Salem Climate Action Plan 2021 highlights this. References to the 2020 Oregon NHMP also show this plan is aligned with the state plan.
- The plan discusses the vulnerability of a wide range of current and future assets. These include people (including socially vulnerable populations), community lifelines, and natural resources.
- The problem statements that summarize vulnerability for each hazard are bolded. They are also explained clearly.

Opportunities for Improvement

- Future plans could include Pandemic as a hazard of concern for Salem due to the impacts of the COVID-19 pandemic.
- Note that FEMA’s National Risk Index also names avalanche, cold wave, hail, ice storm, lightning, and tornado as other hazards of concern in Marion County.

- Table 2 (pp. 14-15) only includes federal disaster declarations. State-related disaster declarations are discussed for extreme heat (p. 63), landslide (p. 111), and wildfire (p. 148). Future plans could include state declarations with federal ones in the summary table.
- Figure 4 (p. 17) would be improved by zooming in on Salem rather than the whole state of Oregon, if possible.
- Figure 7 (p. 23) could be improved with a legend that notes what yellow, orange, red and grey stand for in the chart.
- Figure 38 (p. 120) could be improved by noting the general location or zooming in on Salem.
-

Element C. Mitigation Strategy

Strengths

- Appendix B contains a very in-depth and nuanced discussion of the city's capabilities and capacity.

Opportunities for Improvement

- The city may think about focusing on specific actions for air quality, extreme heat, water quality/emergency, windstorm, and winter storm.

Element D. Plan Maintenance

Strengths

- The city's approach to plain maintenance is clearly outlined.

Opportunities for Improvement

- On page 255, under "Coordinating Body," the second bullet should refer to the "Hazard Mitigation Planning Grant," rather than "Hazard Mitigation Grant."

Element E. Plan Update

Strengths

- Appendix B contains a very in-depth and nuanced discussion of the social resilience of the city; it includes socially vulnerable populations and underserved communities. This discussion includes how current and projected populations may respond to and recover from disasters.

Opportunities for Improvement

- No comment.

Element G. HHPD Requirements (Optional)

Strengths

- N/A

Opportunities for Improvement

- N/A