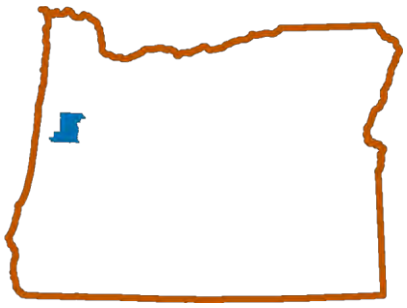
Benton County

MULTI-JURISDICTIONAL NATURAL HAZARDS MITIGATION PLAN



- BENTON COUNTY
- CITY OF ADAIR VILLAGE
- CITY OF CORVALLIS
- CITY OF MONROE
- CITY OF PHILOMATH
- HOSKINS KINGS VALLEY RFPD

FEMA

EFFECTIVE MONTH X, 2024 THROUGH MONTH X, 2029

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SECTION I: INTRODUCTION

Section I provides a general introduction to natural hazard mitigation planning in general and in Benton County. 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 mitigation as ". . . the effort to reduce loss of life and property by lessening the impact of disasters . . . through risk analysis, which results in information that provides a foundation for mitigation activities that reduce risk."[1] Said another way, natural hazard mitigation is a method of permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through long and short-term strategies. Example strategies include policy changes, such as updated ordinances, projects such as seismic retrofits to critical facilities, and education and outreach to targeted audiences within socially vulnerable and underserved populations, such as developing materials for Spanish speaking residents or the elderly. Natural hazard mitigation is the responsibility of the whole community including individuals, private businesses and industries, non-governmental organizations, state and local governments, and the federal government.

Engaging in mitigation activities provides jurisdictions with a number of 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 whole community through the planning process; and increased potential for state and federal funding for coordinated recovery and reconstruction projects.

Why Develop a Mitigation Plan?

Benton County developed this Multi-Jurisdictional Natural Hazards Mitigation Plan (MNHMP or Plan) 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

[1] FEMA, *What is Mitigation?* http://www.fema.gov/what-mitigation

mitigation projects. Local and federal approval of this plan ensures that the county and listed cities will remain eligible for pre- and post-disaster mitigation project grants.

What Federal Requirements Does This Plan Address?

In 2000, Congress passed the Disaster Mitigation Act of 2000, commonly known as DMA 2000. Under this Act and rules published in 44 CFR Part 201.6, states, communities, and tribal governments must complete FEMA-approved natural hazard mitigation plans to be eligible for FEMA Hazard Mitigation Assistance (HMA) funding that includes three programs: Building Resilient Infrastructure & Communities (BRIC), formerly the Pre-Disaster Mitigation grant program, Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance (FMA) program. Mitigation plans must demonstrate that State and local jurisdictions' proposed mitigation measures are based on a sound planning process that accounts for the risk to the individual and state and local jurisdictions' capabilities.

Chapter 44 Code of Federal Regulations (CFR), section 201.6, also requires a local government to have an approved mitigation plan in order to apply for pre-disaster mitigation funds and to receive HMGP (post-disaster) project grants.[2] Pursuant to Chapter 44 CFR, the Natural Hazard Mitigation Plan planning processes must include opportunities for the public to comment on the plan during review, and the updated Natural Hazard Mitigation Plan must include documentation of the public planning process used to develop the plan.[3] 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.[4] Lastly, the Natural Hazard Mitigation Plan must be submitted to Oregon Department of Emergency Management (ODEM) for initial plan review, and then federal approval.[5] Additionally, a recent change in the way ODEM administers the Emergency Management Performance Grant (EMPG), which helps fund local emergency management programs, also requires a FEMA-approved NHMP.

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

Planning for natural hazards is an integral element of Oregon's Statewide Land Use Planning program, which began in 1973. All Oregon cities and counties have comprehensive plans and implementing ordinances that are required to comply with the Statewide Land Use Planning Goals. 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 governments to adopt comprehensive plans including inventories, policies and

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[2] Code of Federal Regulations, Chapter 44. Section 201.6, subsection (a), 2015

[3] ibid, subsection (b). 2015

[4] ibid, subsection (c). 2015

[5] ibid, subsection (d). 2015

implementing measures to reduce risk to people and property from natural hazards. These policies and implementing measures should guide development by avoiding development in hazard areas where risk to people and property cannot be mitigated and by prohibiting the siting of essential facilities, major structures, hazardous facilities and special occupancy structures in identified hazard areas where the risk to public safety cannot be mitigated unless the essential facility is needed within a hazard area in order to provide essential emergency response services in a timely manner.[6] Natural hazards specifically identified in Goal 7 include floods (coastal and riverine), landslides, earthquakes and related hazards, tsunamis, coastal erosion, and wildfires. 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 Benton County's Comprehensive Plan, and helps each jurisdiction meet the requirements of Statewide Land Use Planning Goal 7.

The primary responsibility for the development and implementation of risk reduction strategies and policies lies with local jurisdictions. However, additional resources exist at the state and federal levels. Some of the key agencies in this area include 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 Department of Land Conservation and Development (DLCD).

How was the Plan Developed?

The plan was developed by the Benton County Natural Hazard Mitigation Plan Steering Committee and the local update committees for the cities of Adair Village, Corvallis, Monroe, and Philomath and the Board of Directors and Fire Chief of the Hoskins Kings Valley Rural Fire Protection District.

The Code of Federal regulations requires that the planning process include opportunities for the public, neighboring communities, local and regional agencies, as well as private and non-profit entities to comment on the plan during review.[7] This was taken into account during the formation of the Steering Committee. Representatives from Interested Parties (Philomath Fire and Rescue District, Oregon State University, Linn Benton Community College, the County Health Department, and the City of Albany, with its standalone plan) participated in meetings and provided their input on Risk Assessment and the planning process.

The Benton County Steering Committee formally convened on nine occasions to discuss and revise the plan. Each of the participating city local plan update committees met at least once formally. Steering Committee members contributed data and maps, and reviewed and updated the community profile, risk assessment, action items, and implementation and maintenance plan.

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[6] Full Text of Goal 7 (oregon.gov)

[7] Code of Federal Regulations, Chapter 44. Section 201.6, subsection (b). 2015

An open public involvement process is essential to the development of an effective plan. Benton County provided information on its website and developed a survey to solicit input from the general public. The county and city websites are where the public most commonly searches for information and the increased response numbers to the survey following the involvement of local volunteers and city staff provides an opportunity for all interested people to participate. The completed draft plan was posted on the county's website to provide an opportunity for feedback simultaneously with the submission of the plan to the Oregon Department of Emergency Management for review.

The Benton County public opinion survey was developed to obtain input from the public regarding the county's risks, vulnerabilities, hazards history, and mitigation strategies. The survey was conducted from March through October and received 231 responses from people living all across the county. The survey was provided on-line both in English and in Spanish. The cities and the special district used the county's link and a QR code to extend the survey to residents in those jurisdictions. The results of the survey were used to inform the Risk Assessment and Mitigation Strategy prior to the completion of the draft plan. One example is the use of survey results concerning public perception of natural hazards and outreach that works to inform the mitigation strategy and how the county prioritized mitigation strategies. The survey and results are provided in Appendix F.

The county, city and special district websites continue to be a focal point for distribution of natural hazard information through the use of hazard viewers, emergency alerts, hazard preparation, and annual natural hazard progress reports.

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 county and city residents, businesses, and the environment. Combined, the sections work together to create a mitigation plan that furthers the community's mission to reduce or eliminate long-term risk to people and their property from hazards and their effects. This plan structure enables readers to locate the section(s) of interest to them.

Volume I: Basic Plan

Plan Summary

The plan summary 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.

Section 1: Introduction

The Introduction briefly describes the countywide 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. This section includes a brief description of community sensitivities and vulnerabilities. The Risk Assessment allows readers to gain an understanding of each jurisdiction's vulnerability and resilience to natural hazards. Additional information is included within Appendix C: Community Profile, which contains an overall description of Benton County, the cities of Adair Village, Corvallis, Monroe, Philomath and the Hoskins Kings Valley Rural Fire Protection District.

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. Three new hazards were added by the Steering Committee for this update. They are underlined below. This NHMP addresses the following hazards:

- Dam Failure
- Drought
- Earthquake
- Epidemic/Pandemic
- Extreme Heat
- Landslide
- Volcano
- Wildfire
- Windstorm
- Winter Storm (Snow/Ice)

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

Section 3: Mitigation Strategy

This section documents the plan vision, mission, goals, and mitigation strategy actions. It also describes aspects of implementation for the mitigation strategy actions. Actions relate to community sensitivity and resilience factors, and the risk assessments in Section 2 and Volume II (City Addenda).

Section 4: Plan Implementation and Maintenance

This section provides information on how the Plan will be implemented and maintained. It describes the process for prioritizing projects and includes a suggested list of tasks for updating the plan for reference at the semi-annual and five-year review meetings.

Volume II: Jurisdictional Addenda

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

In 2016 the cities of Adair Village, Monroe, and Philomath created their first addenda to the Benton MNHMP, while Corvallis opted to combine their stand-alone NHMP as an addendum within the Benton MNHMP. This update revises each of those. This plan update also includes the Hoskins Kings Valley Rural Fire Protection District (HKV RFPD) for the first time.

The five-year update cycle will be the same for the district, all of the cities and the county. The City of Albany is the only incorporated city within Benton County that is not included within this MNHMP; the majority of Albany is located within neighboring Linn County, and the city has developed a stand-alone NHMP.

The plan includes addenda for the following:

- City of Adair Village
- City of Corvallis
- City of Monroe
- City of Philomath
- Hoskins Kings Valley RFPD

Volume III: Mitigation Resources

The resource appendices are designed to provide the users of the Benton County MNHMP with additional information to assist them in understanding the contents of the Plan and provide them with resources to assist with plan implementation.

Appendix A: Mitigation Strategy Actions for All Jurisdictions

The previous plan update utilized a common suite of mitigation strategies for all jurisdictions that joined the plan in 2016. During the current update these template mitigation strategy actions were examined in detail and revised in order to reflect the particular application of the template strategy to the conditions in each jurisdiction. In order to track these changes from the 2016 plan update through the current one, this appendix lists all mitigation strategies for all jurisdictions in a table that tracks those changes from template mitigation strategy to jurisdiction specific mitigation strategy actions.

Appendix B: Planning and Public Process

This appendix includes documentation of all the countywide public processes utilized to develop the plan. It includes invitation lists, agendas, sign-in sheets, and summaries of Steering Committee meetings as well as a summary of the public input gained through the survey.

Appendix C: Community Profile

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

Appendix D: Economic Analysis of Natural Hazard Mitigation Projects

This appendix describes the Federal Emergency Management Agency's (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 state and federal resources and programs by hazard.

Appendix F: Community Survey

Appendix F includes the survey instrument and results from the preparedness survey implemented by Benton County, the cities and the special district participating in this 2023 Multi-jurisdictional Natural Hazard Mitigation Plan update.

Appendix G: DOGAMI Multi-Hazard Risk Assessment for Benton County

Appendix H: OCCRI Future Climate Projections, Benton County

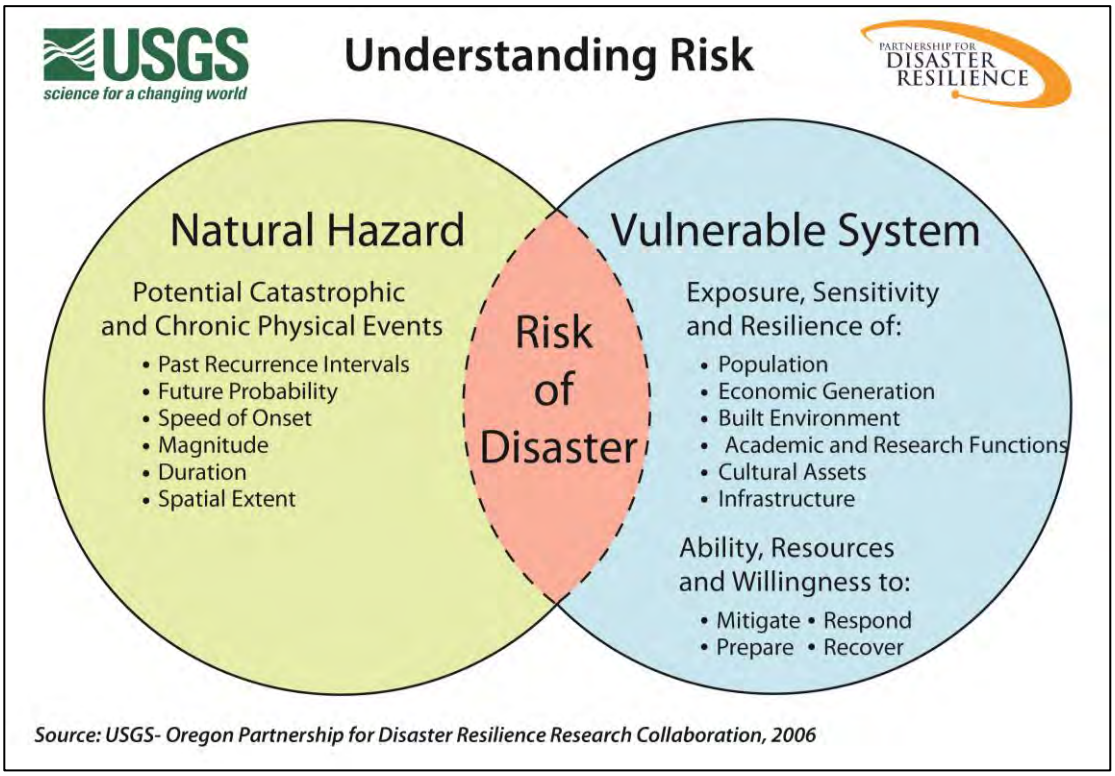
Appendix I: Approval Letters, Review Tool, and Resolutions

SECTION 2:
RISK ASSESSMENT

The Risk Assessment was developed by the prospective plan holders of the Benton County Multi-Jurisdictional Natural Hazard Mitigation Plan. These include Benton County, the Cities of Adair Village, Corvallis, Monroe, and Philomath, and the Hoskins Kings Valley Rural Fire Protection District (HKV RFPD). City and district specific information is called out where relevant. In addition, this chapter can assist with addressing Oregon Statewide Planning Goal 7 – Areas Subject to Natural Hazards.

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

Figure 1. Understanding Risk



Source: Oregon Partnership for Disaster Resilience.

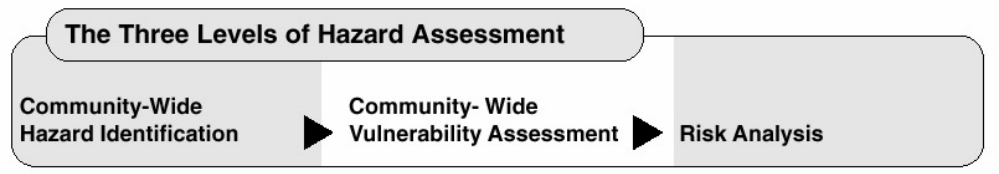
What is a Risk Assessment?

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

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

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

Figure 2. Three Phases of a Risk Assessment



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

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

Phase I: Hazard Identification and Characterization

The first step taken with the Steering Committee was the identification of any needed revisions due to changes in community priorities. The inclusion of the impact of a changing climate was highlighted and incorporated into relevant mitigation strategies. The importance of adding new natural hazards to the plan was another change made to better reflect Benton County priorities.

Benton County's Steering Committee considered the natural hazard events that have occurred since 2016 and concluded that three new hazards should be added to the Plan. These include Extreme Heat, Epidemic/Pandemic and Dam Failure.

The notable natural hazard events identified by the NOAA Storm Event Database, within the Oregon Department of Forestry Fire database and by Steering Committee members that occurred in Benton County since 2016 are described in the table below.

Table 1. Weather Related Natural Hazard events NOAA Storm Events Database 2016 – 2022
(Categorized by natural hazard type and then date)

Hazard Event Type	Episode Dates	Event Description[8]
Excessive Heat	June 26-29, 2021	Very hot temperatures. There were three consecutive days with maximum temperatures greater than 95 degrees measured at several stations, with two consecutive days greater than100 degrees. The hottest day was on June 27 where temperatures peaked around 109 degrees.
Excessive Heat	August 11-12, 2021	There were two consecutive days with maximum temperatures greater than 100 degrees. The hottest day was June 27 where temperatures in the area peaked around 112 degrees. Record breaking temperatures up to 111 degrees F in Eugene, OR. There was one heat related death reported. High Heat days on July 29, 2021, and August 18, 2021, bracketed this event with daytime temperatures in the high 90's and nighttime temperatures in the 60's.
Heat	August 17, 2022	High pressure centered over the Desert Southwest expanded over the Pacific Northwest bringing a brief hot spell to the area. High temperatures on the 17th were in the mid to upper 90s. For example, the high temperature at Mahlon Sweet Field (KEUG) was 97 degrees. Overnight temperatures were quite warm with lows in the 60s.
Flood	November 25, 2016	Heavy rain resulted in flooding of the Marys River near Philomath. The Marys River reached flood stage at 205 AM on November 25th and crested at 21.21 feet at 1030 AM on November 25th. The river dropped below flood stage at 800 AM on November 26.
Flood	February 9, 2017	Heavy rain caused the Marys River near Philomath to flood. The river crested at 20.54 feet, which is 0.54 feet above flood stage.
Flood	April 9-11, 2019	The Long Tom River near Monroe crested at 9.1 feet around 4 PM on April 8th, which is 0.1 foot above flood stage. The Willamette River near Corvallis crested at 32.8 feet around 9 AM on April 10th, which is 2.8 feet above flood stage.
Flood	December 21, 2020	The Marys River near Philomath (PHIO3) crested at 20.4 feet. Flood stage is 20.0 feet. No damage was reported.
Flood	January 14, 2021	The Marys River near Philomath (PHIO3) rose above flood stage around 2130PST, crested at 21.23 feet, then fell below flood stage at 0430PST on the 14th. Flood stage is 20.0 feet.

[8] Event descriptions from the NOAA Storm Event Database, consulted February 2023.

Hazard Event Type	Episode Dates	Event Description[8]
Flood	January 5, 2022	The gauge on the Marys River near Philomath rose above flood stage of 20 feet around 0920PST, crested at major flood stage of 21.0 feet at 1500 PST, then dropped below flood stage on the 5th at 0340PST.
Winter Storm	December 14, 2016	Snow, followed by freezing rain. The freezing rain turned into a major ice storm occurred in Eugene and the vicinity with 0.5 to 1.0 inch of ice accumulation observed. There was significant damage to trees and power lines, and fairly widespread power outages across the region. 15,000 people were without power.
Winter Storm	January 7-8, 2017	General snowfall totals of 2-4 inches were reported, with the greatest total being 4.5 inches from the observer at Eugene Airport. Major ice accumulations occurred after the snow, with several locations reporting 0.50-1.00. The combination of snow and ice resulted in significant power outages and closures across the area.
Heavy Snow	March 5-6, 2017	The Benton County Emergency Manager reported snowfall rates above 650 feet of 2 inches per hour. By 6:22 pm, Highway 34 was impassable at the summit. A CoCoRaHS observer 7 miles NNW of Philomath recorded 5.9 inches of snow.
Heavy Snow	February 24-25, 2019	Generally, amounts of 8 to 16 inches of heavy, wet snow were reported generally around Brownsville southward, while lesser amounts of 1 to 4 inches were reported around Corvallis and Albany. The weight of the snow brought down hundreds, if not thousands of trees, resulting in numerous road closures and extended power outages. Heavy snow caused a roof to collapse at a high school gym. 1,340,000 properties were affected by this event.
Heavy Snow	February 26-27, 2019	There were several public reports of 4 to 8 inches of snow. This storm hampered recovery efforts from the February 24-25 snowstorm, extending power outages for many customers.
Ice Storm	February 12-13, 2021	A trained spotter in Blodgett in Benton County reported 0.75 inch of ice before it started melting the morning of the 13th.
Heavy Snow	December 24-25, 2021	Snow showers increased the night of the 25th, continuing through the 26th, resulting in significant travel issues for the holiday weekend. Widespread snowfall amounts of 4 to 10 inches were reported.
High or Strong Wind	28 episodes during the period. See the Windstorm section below for specific dates.	Sustained winds during episodes within the Central Coast Range ranged between 51 and 90 miles per hour. Sustained winds within the Southern Willamette Valley ranged between 30 and 46 miles per hour.

Wildfire occurrences are catalogued by the Oregon Department of Forestry.[9] The subset of those fires that occurred between the 2016 and 2022 fire years in Benton County include 57 incidents 39 of which were classified as Size Class A having burned less than 0.5 acres. Most of these burned less than 0.1 acres. There were Class C fires in Benton County between the 2016 and 2022 fire years. All but one of these fires were human caused. Of these human-caused fires, debris burning, sparks or heat from equipment use, trees falling on power lines, campfires not extinguished, and fireworks were among the common specific causes.

Table 2. Selected fires 2016-2022

Fire Name	Ignition Date & Time	Size class	Estimated Total Acres	Human or Lightning	General Cause
Peavy Arboretum	7/2/2016 18:00	B	3.60	Human	Recreation
Bruce Rd Fire	7/15/2016 16:30	B	0.50	Human	Equipment Use
North Bellfountain	8/14/2016 15:25	B	0.37	Human	Arson
South Bellfountain	8/14/2016 15:25	B	0.31	Human	Arson
Witham Hill	8/15/2016 16:30	B	0.60	Human	Recreation
Peterson Road	6/25/2017 15:50	B	2.40	Human	Equipment Use
Chinook	4/24/2018 11:50	B	1.17	Human	Debris Burning
Powerline	7/12/2020 16:50	B	0.26	Human	Equipment Use
Yew Cr.	9/7/2020 21:20	B	2.00	Human	Equipment Use
Salmonberry	4/30/2021 15:30	B	0.34	Human	Debris Burning
Maple	7/4/2021 15:39	B	0.65	Human	Recreation
Luckiamute Fire	7/4/2022 15:30	B	1.00	Human	Equipment Use
Hoskins Road Fire	7/30/2022 16:18	B	0.33	Human	Equipment Use
Anderson County Park	8/29/2022 11:38	B	0.90	Human	Miscellaneous
Price Creek Fire	10/17/2022 12:00	B	4.40	Human	Debris Burning
Coon Rd Fire	8/4/2016 17:40	C	29.50	Human	Equipment Use
Lasky Powerline Fire	8/29/2016 11:00	C	11.56	Human	Debris Burning
Norton East	8/17/2022 14:05	C	17.80	Human	Equipment Use

The Plan now identifies eleven natural hazards that could have an impact on the county and each of the participating jurisdictions and districts. Dam Failure, Extreme Heat and Epidemic/Pandemic have been added to the previously identified natural hazards. This list includes Drought, Earthquake, Flood, Landslide, Volcano, Wildfire, Windstorm, and Winter Storm. Summary information covering the characteristics, location and extent, history, probability assessment and vulnerability assessment for each hazard is presented in this section of the Plan. A Cascadia Subduction Zone event and a crustal earthquake event are addressed separately due to the expectation that the impacts would differ. Winter Storm impacts are identified specifically as Snow, Ice and Extreme Cold.

The impact of future climate projections on each relevant hazard is also discussed in the relevant sections. The Oregon Climate Change Research Institute's report on Future Climate

[9] ODF Fire Occurrence Data 2000-2022 | data.oregon.gov | Oregon's Open Data Portal | Oregon.gov

Projections for Benton County identifies with very high, high or medium confidence the impact of rising temperatures on some of these natural hazards including Flood, Drought, Landslide and Wildfire apart from the direct impact to Extreme Heat events. OCCRI has low confidence that there will be any change in Windstorms due to future climate conditions. There is no evidence in the OCCRI analysis that future conditions will have an effect on the type, location or range of intensity of earthquakes, dam failure incidents, winter storms or volcanic events. The complete report is provided as an appendix to the 2023 Benton County MNHMP.

The Risk Assessment uses the Community Profile to describe the nature of the county and the populations that live in the rural land of Benton County. The data describes the vulnerability of people who make their living from ranching, farming, and forestry in Benton County to drought, flood, and wildfire. Low-income families and those in substandard housing may be at risk of impacts of extreme heat. The road system, some critical facilities, and infrastructure are at risk from an earthquake or a tsunami. The electric power transmission system that serves all the county residents and may affect those relying on power for health equipment may be at particular risk from windstorms. The mitigation strategy actions developed to address many of these hazards provide additional detail.

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

Dam Failure

Significant Changes Since Previous Plan:

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

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

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

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

Characteristics

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

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

• "High Hazard" means loss of life is expected if the dam fails.

• "Significant Hazard" means loss of life is not expected if the dam fails, but extensive damage to property or public infrastructure is.

• "Low Hazard" is assigned to all other state-regulated dams.

• "Emergency Action Plan" means a plan that assists a dam owner or operator, and local emergency management personnel, to perform actions to ensure human safety in the event of a potential or actual dam failure.

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

Location and Extent

There is one High Hazard Potential dam in Benton County, the North Fork Dam. The National Inventory of Dams identifies five other dams in Benton County, one of which, Thompson Dam, is identified as a Significant Hazard Potential dam.

Figure 3. National Inventory of Dams found in Benton County, Oregon

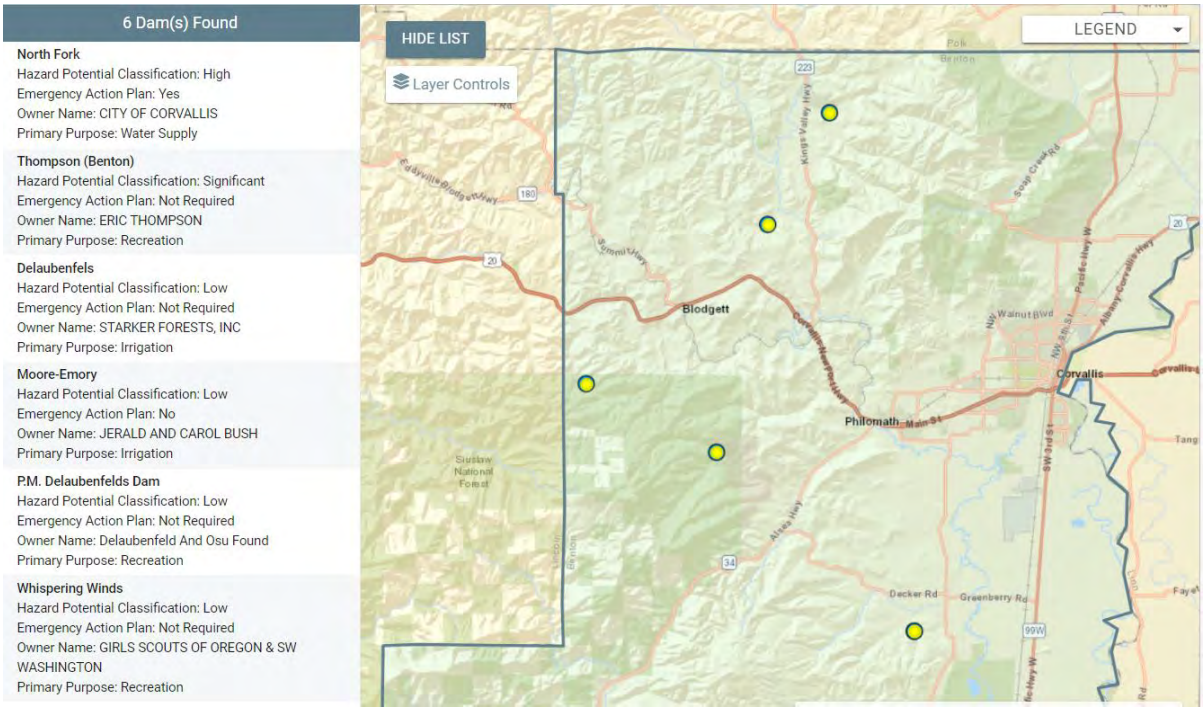


Figure 4. NID Structure Details for North Fork Rock Creek Dam

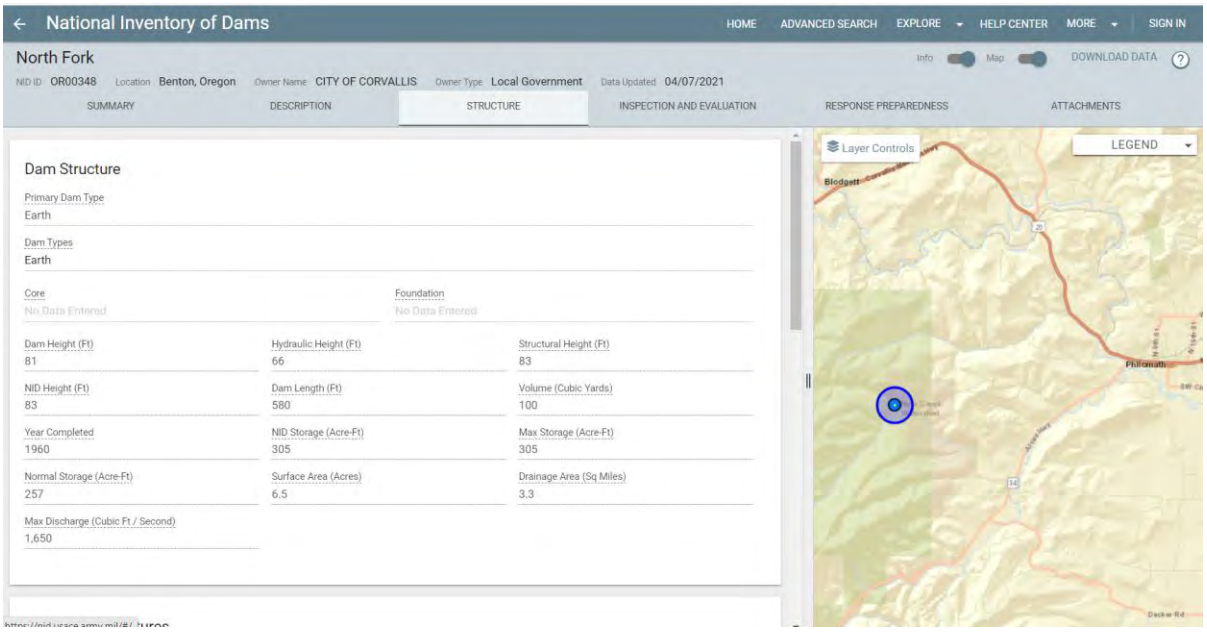
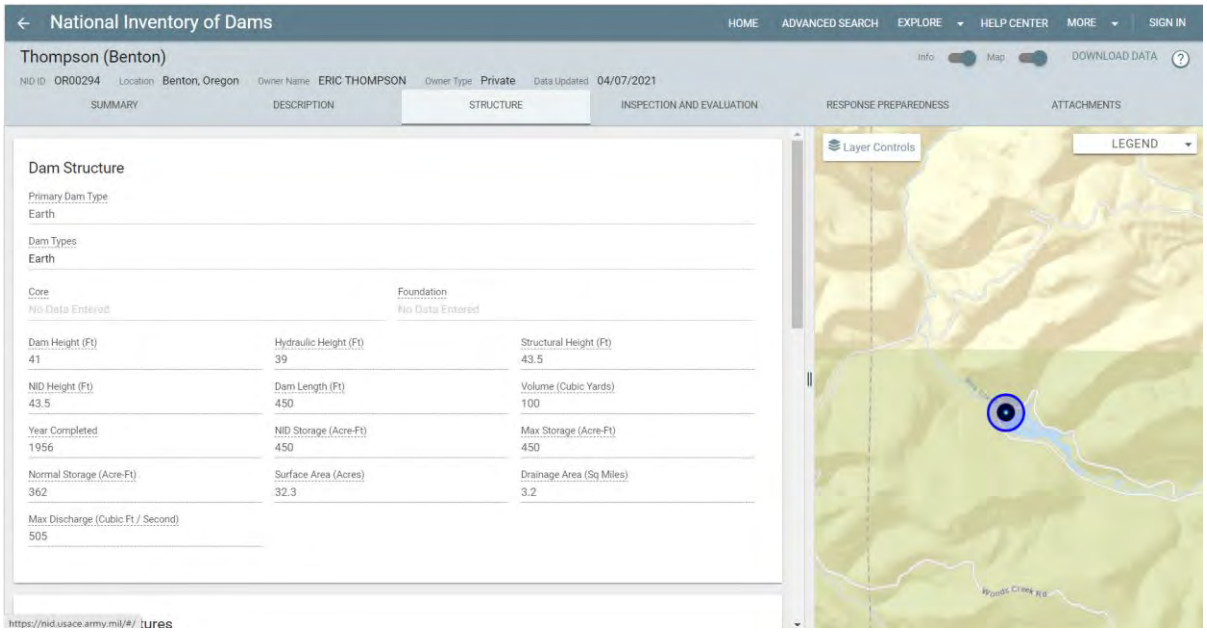
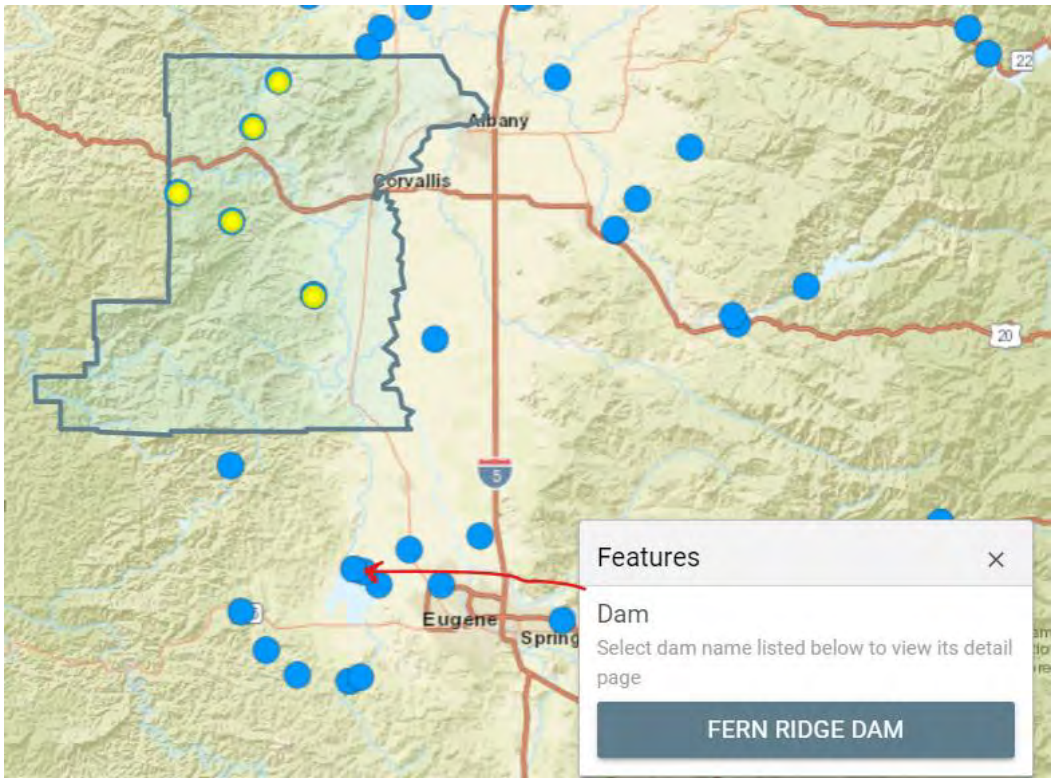


Figure 5. NID Structure Details for Thompson Dam



The inundation threat for the city of Monroe is the breach of the Fern Ridge Dam south of the county near Eugene. The city is at a minor risk from a breach scenario with a high pool level. For more details go to the City of Monroe Addendum in Volume II.

Figure 6. Location of Fern Ridge Dam relative to Benton County



History

Oregon 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, four dam failures have occurred in northeast Oregon, all of which were in Baker County.

Probability Assessment

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

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

Based on the participants' background and experience in Benton County using the OEM-FEMA Risk Assessment methodology (see page 2-99) the NHMP Steering Committee assessed the **probability of experiencing a dam failure as low,** meaning one incident is likely within a 75-100 year period. When Steering Committee members representing Benton County were asked to rank the relative probability of dam failure from among the twelve hazards addressed in this plan, they ranked drought 2.7 out of 12, a low probability.

Vulnerability Assessment

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

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

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

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

Failures of some dams can result in loss of life, damage to property, infrastructure, and the natural environment. The impacts of dam failures range from local impacts to the dam owner's property and waters below the dam to community destruction with mass fatalities. The 1889 Johnston Flood in Pennsylvania was caused by a dam failure and resulted in over 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.

The North Fork Rock Creek Dam EAP was updated in November 2022.

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

Drought

Significant Changes Since Previous Plan:

Both the assessment of Probability and of Vulnerability to Drought increased during the risk assessment phase of this NHMP update.

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 inter-agency 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 Water Resources Department. 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:

- 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 second inter-agency group, the Drought Readiness Council, is co-chaired by the Oregon Water Resources Department and Oregon Departmentof Emergency Management, and reviews local requests for assistance and makes recommendations to the Governor regarding the need for state drought declarations. The Council consists of state agencies with natural resources management, public health, or emergency management expertise.

Characteristics

A drought is a period of drier than normal conditions. Drought occurs in virtually every climatic zone, but its characteristics vary significantly from one region to another. Drought is a temporary condition; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate. The extent of drought events depends upon the degree of

moisture deficiency, and the duration and size of the affected area. Typically, droughts occur as regional events and often affect more than one city and county.

Location and Extent

Droughts occur in every climate zone and can vary from region to region. Drought may occur throughout Benton County and may have profound effects on the economy, particularly the agricultural and hydro-power sectors. Drought is typically measured in terms of water availability in a defined geographical area. It is common to express drought with a numerical index that ranks severity. Most federal agencies use the Palmer Method which incorporates precipitation, runoff, evaporation and soil moisture. However, the Palmer Method does not incorporate snowpack as a variable. Therefore, it is not believed to provide a very accurate indication of drought conditions in Oregon and the Pacific Northwest, 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.[10]

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 take into account both precipitation and potential evapotranspiration in determining drought.

The dimensionless Standardized Precipitation-Evapotranspiration Index (SPEI) is a key quantitative metric for assessing the occurrence and severity of meteorological and hydrological drought. The SPEI compares the net water balance between precipitation and potential evapotranspiration between a recent period of time and a historical period.[11]

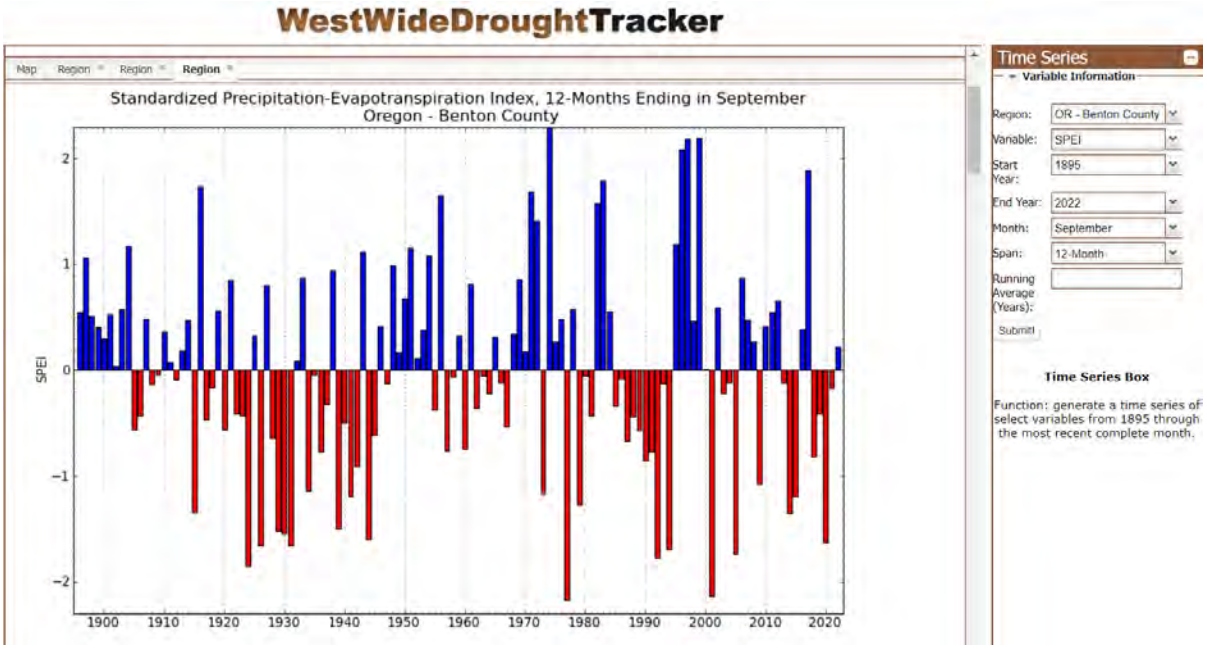
The SPEI allows for comparison of drought severity in different locations and times and for identification of different drought types, including consideration of the role of temperature in drought assessment. The 12-month SPEI is a reliable predictor of annual streamflow in the Northwest and water levels in lakes and reservoirs.[12] 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).

[10] https://climatedataguide.ucar.edu/climate-data/palmer-drought-severity-index-pdsi

[11] Fifth Oregon Climate Assessment, 2021; OCAR5.pdf | Powered by Box

[12] Ibid.

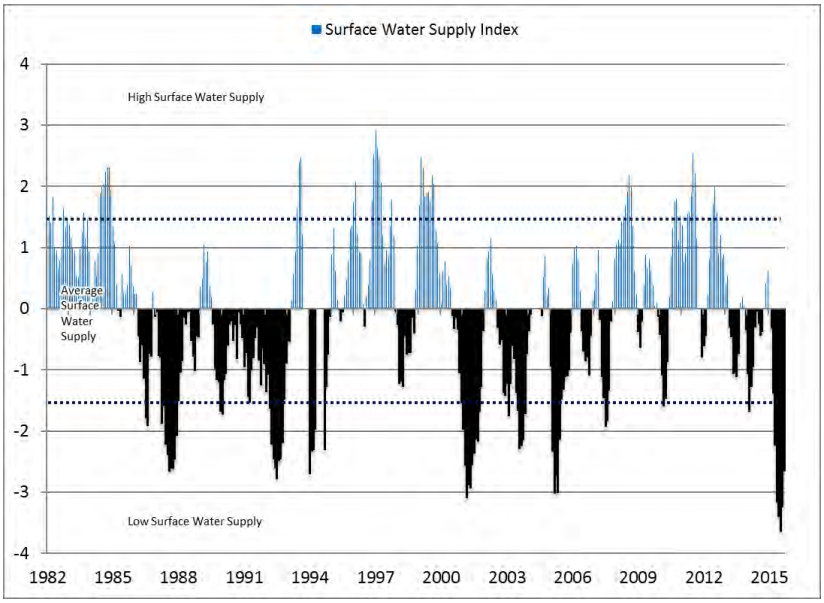
Figure 7. SPEI Index 1900-2022



Source: West Wide Drought Tracker consulted March 2023; [WWDT (dri.edu)]

Figure 8 below shows the monthly history of SWSI values from February 1982 to October 2015 for the Willamette Basin which includes Benton County. Research shows that the periods of drought have fluctuated; recent drought periods occurred in 1987, 1992, 1994, 2001, 2003, 2005, and 2015.

Figure 8. SWSI Values for the Willamette Basin (1982-2015)

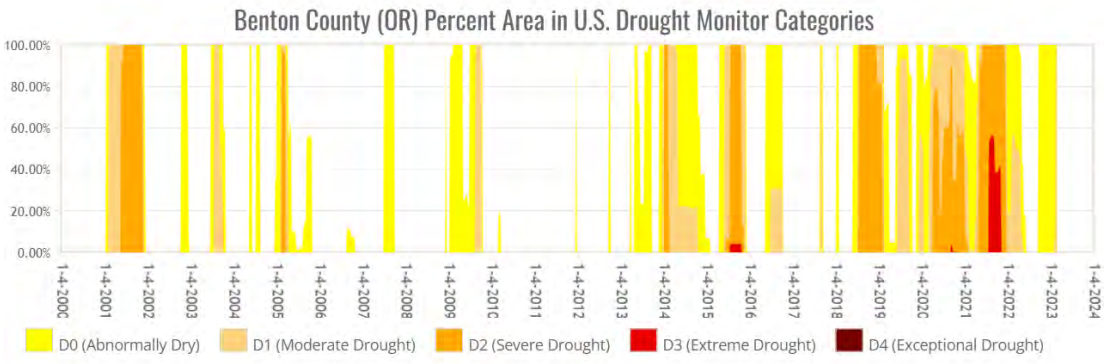


Source: Department of Agriculture-Natural Resources Conservation Service, "Surface Water Supply Index, Willamette Basin" www.or.nrcs.usda.gov. Accessed February 2016.

The Drought Monitor is the current primary tool used to identify and categorize drought conditions in Oregon [https:/droughtmonitor.unl.edu/]).

This is what makes the U.S. Drought Monitor unique. It is not a statistical model, although numeric inputs are many: the Palmer Drought Severity Index, the 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.

Figure 9. U.S. Drought Monitor conditions in Benton County from 1/2022 to 1/2023



This graph shows that portions of Benton County were experiencing Extreme Drought (D3) conditions in late 2021, but those conditions have abated at the current time.

El Niño and La Niña

El Niño and La Niña are the warm and cool phases of a recurring climate pattern across the tropical Pacific—the El Niño-Southern Oscillation, or "ENSO" for short. The pattern shifts back and forth irregularly every two to seven years, bringing predictable shifts in ocean surface temperature and disrupting the wind and rainfall patterns across the tropics. These changes have a cascade of global side effects.[13]

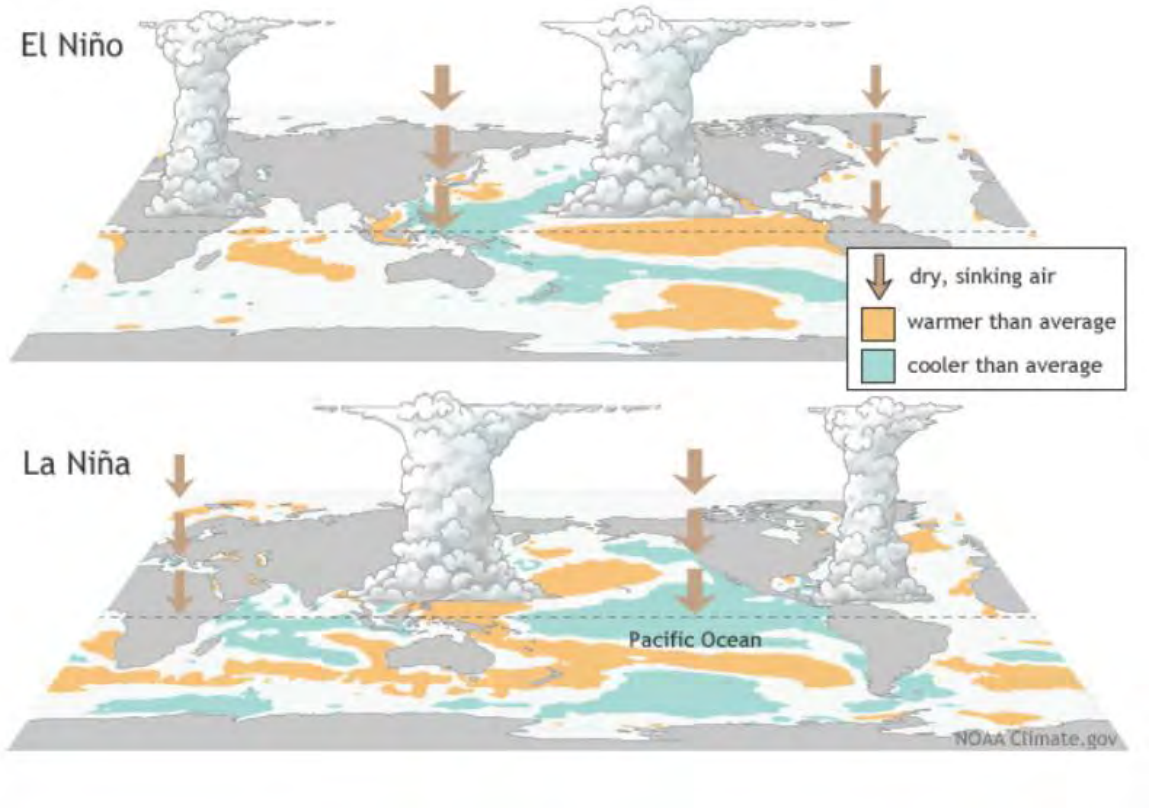
El Niño Southern Oscillation weather patterns can increase the frequency and severity of drought. During El Niño periods, alterations in atmospheric pressure in equatorial regions yield an increase in the surface temperature off the west coast of North America. This gradual warming sets off a chain reaction 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.

La Niña strengthens the normal atmospheric circulation across the tropical Pacific Ocean. One side effect is a strong high-pressure area in the Northeast Pacific. Like a boulder in a

[13] El Niño & La Niña (El Niño-Southern Oscillation) | NOAA Climate.gov

river, this high pressure changes the flow of storms as they approach the western U.S., favoring wet winters in the Northwest and dry winters across the South.[14]

Figure 10. ENSO weather patterns



History

Drought conditions are not uncommon in Benton County.

One recent drought event, and one previously omitted drought event, have been added to the hazard history since the previous plan (as shown in *italics* below):

- 1904-1905: A statewide drought period of about 18 months
- 1917-1931: A very dry period throughout Oregon, punctuated by brief wet spells in 1920-21 and 1927
- 1939-1941: A three-year intense drought in Oregon
- 1976-1981: Intense drought in western Oregon; 1976-1977 single driest year of century (eclipsed only by 2015 water-year)
- 1986: Drought conditions in Benton County open eligibility for USDA loans

[14] Ibid.

- 1987: Drought conditions contribute to job losses in Pacific Northwest timber industry
- 1990-1991: Drought conditions lead to USDA payments to impacted farmers
- *1992: Formal Governor Declared Determination of State of Drought includes Benton County*
- 1999: Drought conditions open eligibility to non-farm businesses and agricultural cooperatives to receive low-interest loans to assist with financial obligations
- 2000-2001: Klamath drought intensifies; low snowpack in mountains worsens conditions. Due to lack of water Bonneville Power Administration asked some consumers (industrial and residential) to limit power use
- 2005: Due to water rationing some farmers are cutting back production of certain crops including wheat and hay
- 2007: Farmers in Oregon allowed to use USDA Conservation Reserve Program to expand available land outside of drought-stricken counties
- August 2015: Federal Drought Declaration due low snow pack levels, and low water conditions.

At the time of this writing June 2023, Benton County is still ranked by the U.S. Drought Monitor as D0 - Abnormally Dry to D1 - Moderate Drought conditions and the SPEI index is just on the positive side.

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.

Oregon Climate Change Research Institute's (OCCRI) analysis of Future Climate Projections for Benton County presents projected changes in four variables indicative of drought: low spring (April 1) snowpack (snow drought), low summer (June–August) soil moisture from the surface to 55 inches below the surface (agricultural drought), low summer runoff (hydrological drought), and low summer precipitation (meteorological drought). OCCRI presents drought 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 50% (snowpack) or 20% (5-year return period) (soil moisture, runoff, and precipitation) (Figure 11). [15]

In Benton County, summer soil moisture, spring 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 (Figure 11). By the 2050s under the higher emissions scenario, the annual probability of snow drought is projected to be about 71% (1.4-year return period). The annual probabilities of agricultural, hydrological, and meteorological drought are projected to be about 34% (2.9-year return period), 38% (2.6-year return period), and 33% (3.0-year return period), respectively. We did not evaluate drought projections for the 2020s

[15] Oregon Climate Change Research Institute (OCCRI), Future Climate Projections, Benton County, Oregon, April 2023

due to data limitations, but drought magnitudes in the 2020s likely will be smaller than those in the 2050s.

Figure 11. Projected Future Drought in Benton County

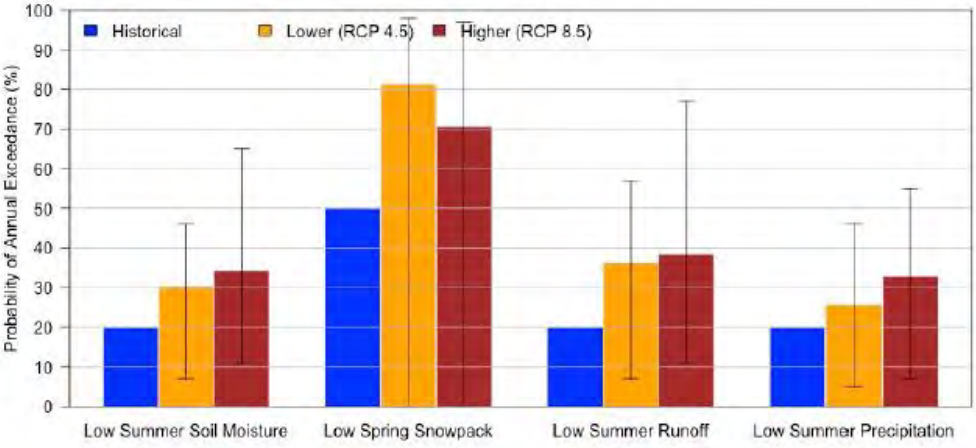


Figure 14. Projected probability of exceeding the magnitude of seasonal drought conditions for which the historical annual probability of exceedance was 20% (50% for spring snowpack). Projections are for the 2050s (2040–2069), relative to the historical baseline (1971–2000), under two emissions scenarios. 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,

Based on the knowledge and experience of participants on the Benton County NHMP Steering Committee, and using the OEM-FEMA methodology (see page 2-99) participants assessed the **probability of experiencing a locally severe drought to be high,** meaning one incident is likely within the next 35-year period. *This rating is slightly higher than the rating during the previous plan update.* When Steering Committee members representing Benton County were asked to rank the relative probability of drought from among the twelve hazards addressed in this plan, they ranked drought 7.6 out of 12, a moderate probability.

Vulnerability Assessment

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

All parts of Benton County are susceptible to drought however, the following areas and issues are of particular concern:

- Drinking water system
- Power and water enterprises

- Residential and community wells in rural areas (including Alsea and Cascade View Service Districts)
- Fire response capabilities
- Fish and wildlife

Potential impacts to community water supplies and farming are the greatest threats. Additionally, long-term drought periods of more than a year can impact forest conditions and set the stage for potentially destructive wildfires.

The NHMP Steering Committee using the OEM methodology (see 2-99) rated the county as having **a moderate vulnerability to drought hazards**, meaning between 1% and 10% of the region's population or assets would be affected by a major drought emergency or disaster. *This rating has increased since the previous plan*. When Steering Committee members representing Benton County were asked to rank the relative vulnerability of residents to drought from among the twelve hazards addressed in this plan, they ranked drought 6.1 out of 12, a moderate probability.

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

Earthquake

Significant Changes Since Previous Plan:

There has not been any new data, or history, as such the material has remained largely the same. The studies that support the assessment of vulnerability were summarized and the 2023 DOGAMI multi-hazard risk assessment was cited. The probability and vulnerability ratings were updated to distinguish between a Cascadia Subduction Zone event and a crustal event. Large areas of Benton County fall within 2 of the zones identified in the Oregon Resilience Plan as having significantly different probabilities and vulnerabilities in a Cascadia Subduction Zone event. These differences have been incorporated throughout this section.

Characteristics

The Pacific Northwest in general is susceptible to earthquakes from four sources: 1) the offshore Cascadia Subduction Zone; 2) deep intraplate events within the subducting Juan de Fuca Plate; 3) shallow crustal events within the North American Plate, and 4) earthquakes associated with volcanic activity.

All types of earthquakes in the region have some tie to the subducting, or diving, of the dense, oceanic Juan de Fuca Plate under the lighter, continental North American Plate. There is also a link between the subducting plate and the formation of volcanoes some distance inland from the offshore subduction zone.

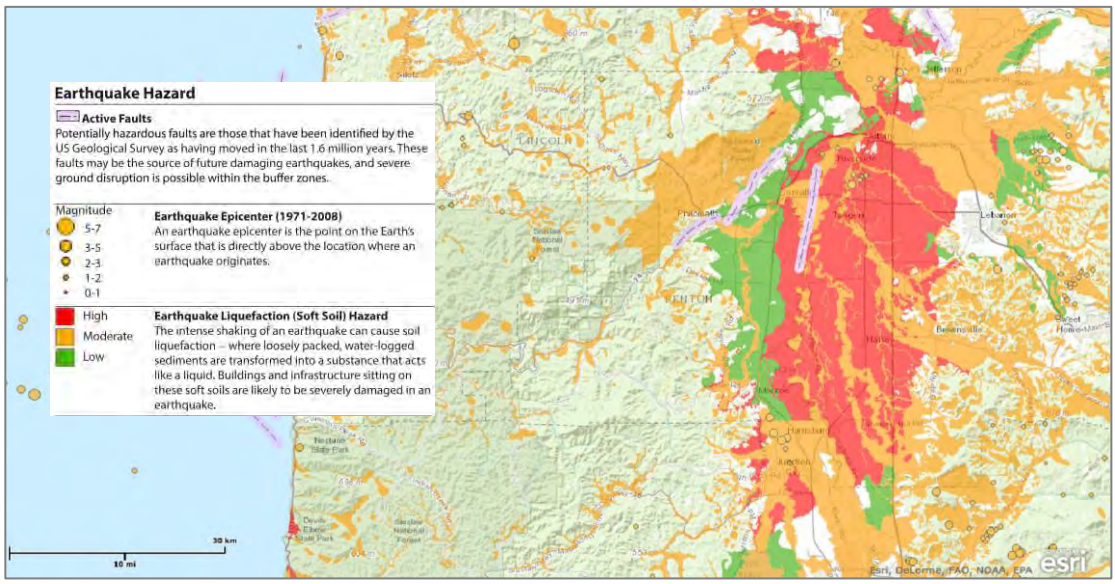
Location and Extent

There have been several significant recent earthquakes in the region; however, all significant events have been located in Klamath and Lake Counties in southern Oregon. The region has also been shaken historically by crustal and intraplate earthquakes and

prehistorically by subduction zone earthquakes centered outside Central Oregon. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region, or along the offshore Cascadia Subduction Zone.

Figure 12 shows a generalized geologic map of Benton County and includes the Corvallis Fault (west of Corvallis), the Owl Creek Fault (east of Corvallis), and the Mill Creek Fault (north of Albany). The earthquakes shown in the figure below are relatively insignificant events below M 2.0. The larger events may have been slightly felt but little to no structural/property damage resulted. Thus, the seismic hazard for Benton County arises predominantly from major earthquakes on the Cascadia Subduction Zone. Smaller, crustal earthquakes in or near Benton County could be locally damaging but would not be expected to produce widespread or major damage.

Figure 12. Earthquake Epicenters (1971-2008), Active Faults, and Soft Soils



Source: [Oregon HazVu: Statewide Geohazards Viewer (HazVu)]

The Oregon Department of Geology and Mineral Industries (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. DOGAMI has published a number of seismic hazard maps that are available for communities to use. The maps show liquefaction, ground motion amplification, landslide susceptibility, and relative earthquake hazards. This NHMP update used the DOGAMI Statewide Geohazards Viewer 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 a number of 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.

For more information, see the following reports:

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

Open-File Report O-13-06, Ground motion, ground deformation, tsunami inundation, coseismic subsidence, and damage potential maps for the 2012 Oregon Resilience Plan for Cascadia Subduction Zone Earthquakes.

Interpretive Map Series: IMS-024 - 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, 2008

Open-File-Report: O-07-02 - Statewide seismic needs assessment: Implementation of Oregon 2005 Senate Bill 2 relating to public safety, earthquakes, and seismic rehabilitation of public buildings, 2007

Open-File-Report: O-03-02 – Map of Selected earthquakes for Oregon (1841-2002), 2003

Open-File-Report: O-01-05 - Preliminary earthquake hazard and risk assessment and water-induced landslide hazard in Benton County, Oregon, 2001

Additional reports are available via DOGAMI's Publications Search website: Oregon Department of Geology and Mineral Industries : Publications Search : Publications Center : State of Oregon

Other agency/ consultant reports:

Regional All Hazard Mitigation Master Plan for Benton, Lane, and Linn Counties: Phase II (2001)

Oregon Seismic Safety Policy Advisory Commission Reports:

Oregon Resilience Plan Executive Summary (February 2013)

Oregon Resilience Plan Full report (February 2013)

History

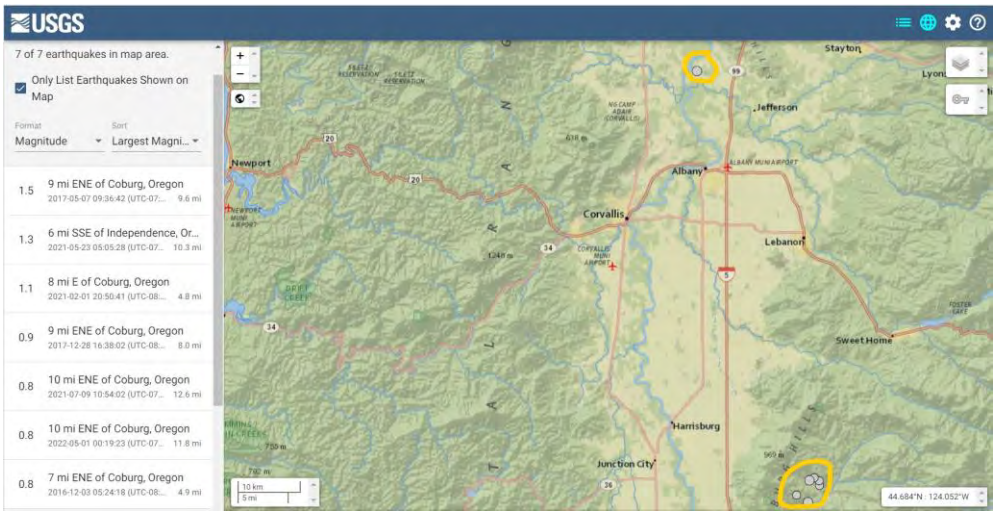
Benton County has not experienced any major earthquake events in recent history. A 4.4 magnitude earthquake did occur in Sweet Home in 2022. Seismic events do, however, pose a significant threat. In particular, a Cascadia Subduction Zone (CSZ) event could produce catastrophic damage and loss of life in Benton County.

Benton County has elected to keep the two types of potential earthquakes separate due to a concern that the CSZ scenario might affect the county differently. Following a CSZ event the county may receive evacuees from that event. The recovery efforts that would be needed may differ from those following a crustal earthquake.

According to the Oregon NHMP, the return period for the largest of the CSZ earthquakes (Magnitude 9.0+) is 530 years with the last CSZ event occurring 314 years ago in January of 1700. The probability of a 9.0+ CSZ event occurring in the next 50 years ranges from 7 - 15%. Notably, 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 roughly 240 years. The combined probability of any CSZ earthquake occurring in the next 50 years is 37 - 43%.

While Benton County has not experienced any significant earthquakes in recent history. During the period from January 2016 to March 2023 the U.S. Geologic Service database identifies seven very small earthquakes in the vicinity of Benton County that ranged from 1.53 to 0.8 magnitude

Figure 13. Earthquakes near Benton County from January 2016 to March 2023



Source: USGS Latest Earthquakes map consulted March 2023 [Earthquakes | U.S. Geological Survey (usgs.gov)]

Earthquakes in Oregon that have affected Benton County are listed below[16]:

- January 1700: Offshore, Cascadia Subduction Zone (CSZ)- Approximate 9.0 magnitude earthquake generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast (additional CSZ events occurred approximately in 1400 BCE, 1050 BCE, 600 BCE, 400, 750, and 900)
- November 1896: McMinnville, 4.0 magnitude
- July 1930: Perrydale, 4.0 magnitude
- April 1949: Olympia, WA, 7.1 magnitude, significant damage in Washington, minor damage in NW Oregon
- August 1961: Albany, 4.5 magnitude, minor damage in Albany
- November 1962: Portland area, 5.5 magnitude, shaking lasted up to 30 seconds; chimneys cracked; windows broken; furniture moved
- March 1963: Salem, 4.6 magnitude, minor damage in Salem
- March 1993: Scotts Mills- A 5.6 magnitude earthquake caused $27-$30 million in damages to homes, schools, businesses, state buildings (Salem). Crustal Event (FEMA-985-DR-OR)
- September 1993: Klamath Falls- Two earthquakes (5.9-6.0) caused two deaths and extensive damage. $7.5 million in damage to homes, commercial, and government buildings. Crustal event (FEMA-1004-DR-OR)

[16] Ivan Wong and Jacqueline D.J. Bolt, 1995, "A Look Back at Oregon's Earthquake History, 1841-1994", Oregon Geology, pp. 125-139.

The Pacific Northwest Seismic Network: Notable Pacific Northwest Earthquakes since 1993

- February 2001: Nisqually, WA, 6.8 magnitude, felt in region, no local damage reported
- October 7, 2022: Northeast of Sweet Home 4.4 magnitude quake

Probability Assessment

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

According to the Oregon NHMP, the return period for the largest of the CSZ earthquakes (Magnitude 9.0+) is 530 years with the last CSZ event occurring 314 years ago in January of 1700. The probability of a 9.0+ CSZ event occurring in the next 50 years ranges from 7 - 12%. Notably, 10 - 20 "smaller" 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 roughly 240 years. The combined probability of any CSZ earthquake occurring in the next 50 years is 37 - 43%.

Establishing a probability for crustal earthquakes is difficult given the small number of historic events in the region. Earthquakes generated by volcanic activity in Oregon's Cascade Range are possible, but likewise unpredictable. For more information see DOGAMI reports linked above.

Based on the knowledge and experience of participants on the Benton County NHMP Steering Committee, and using the OEM-FEMA Methodology (see page 2-99), participants assessed the **probability of experiencing a Cascadia Subduction Zone (CSZ) or a crustal earthquake is "moderate",** meaning one incident is likely within the next 50-year period. The previous NHMP rated the crustal earthquake probability and the CSZ earthquake probability as "moderate". When the Benton County representatives were asked to rank the probability of both earthquake scenarios from among the twelve natural hazards addressed in this plan, they ranked the probability as 3.4 (crustal) and 3.3 (CSZ) out of 12; both are low rankings.

Cascadia Subduction Zone

Paleoseismic studies along the Oregon coast indicate that the state has experienced seven Cascadia Subduction Zone (CSZ) events possibly as large as magnitude (M) 9 in the last 3,500 years. These events are estimated to have an average recurrence interval between 500 and 600 years, although the time interval between individual events ranges from 150 to 1,000 years. The last CSZ event occurred approximately 300 years ago. Scientists estimate the chance in the next 50 years of a great subduction zone earthquake is between 10 and 20 percent, assuming that the recurrence is on the order of 400 +/- 200 years.

New research from Oregon State University suggests that the CSZ has at least 4 segments that sometimes rupture independently of one another. M9 ruptures affecting the entire subduction zone have occurred 19 times in the past 10,000 years. Over that time, shorter segments have ruptured farther south in Oregon and Northern California, producing magnitude-8 quakes. As such, the risks of a subduction zone quake may differ from north to south. Quakes originating in the northern portion of the CSZ tend to rupture the full length of the subduction zone. In southern Oregon and Northern California, quakes along the subduction zone appear to strike more frequently.

Benioff (Deep) Zone

Deep intraplate earthquakes may have magnitudes up to 7.5, with probable recurrence intervals of about 500 to 100 years (recurrence intervals are poorly determined by current geologic data).

Crustal Zone

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

Vulnerability Assessment

The local faults, the county's proximity to the Cascadia Subduction Zone, potential slope instability, and the prevalence of certain soils subject to liquefaction and amplification combine to give the county a high-risk profile. Due to the expected pattern of damage resulting from a CSZ event, the Oregon Resilience Plan divides the State into four distinct zones and places Benton County predominately within the "Willamette Valley Zone" (Valley Zone, from the summit of the Coast Range to the summit of the Cascades), however, portions of the county are within the "Coastal Zone" (the area outside of the tsunami zone, from the Oregon coastline to the summit of the Coast Range)[17]. 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.[18] Within the Coastal Zone damage and shaking is expected to be severe and communities will be isolated, the main priority after an event will be to keep the population sheltered, fed, and healthy.[19]

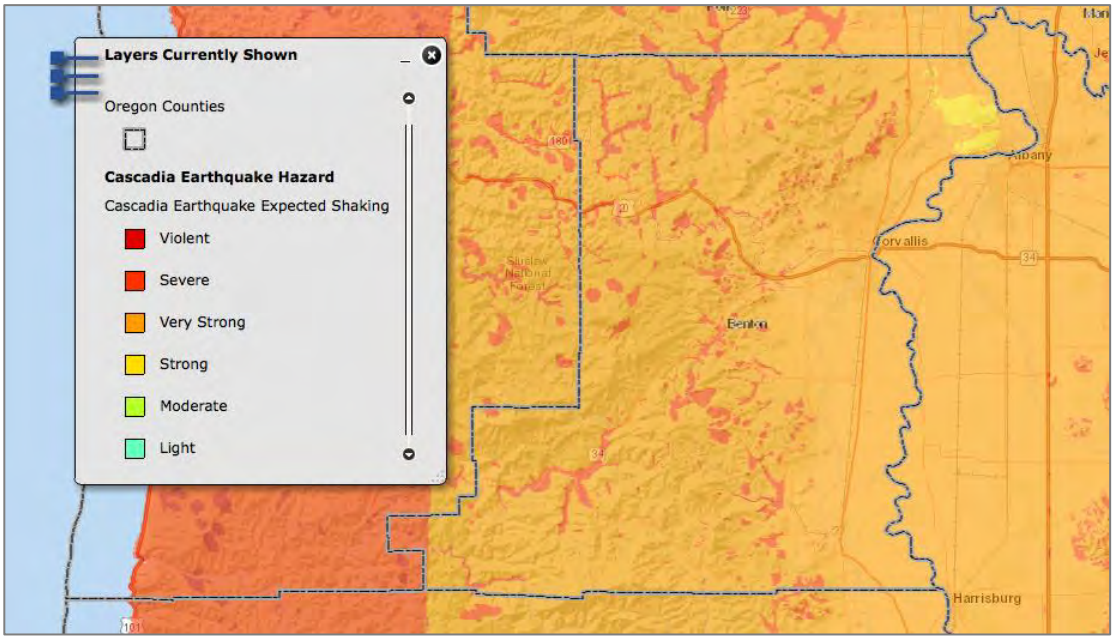
Figure 14 below shows the expected shaking/ damage potential for Benton County as a result of a Cascadia Subduction Zone (CSZ) earthquake event. The figure shows that the county will experience "very strong" to "severe shaking" that will last two to four minutes. The strong shaking will be extremely damaging to lifeline transportation routes including Highway 34. For more information on expected losses due to a CSZ event see the Oregon Resilience Plan (ORP). Several of the county and city mitigation actions utilize the analysis within the ORP as justification and to inform their rationale.

[17] Oregon Seismic Safety Policy Advisory Commission, *Oregon Resilience Plan* (2013)

[18] Ibid.

[19] Ibid.

Figure 14. Cascadia Subduction Zone Damage Potential



Source: [Oregon HazVu: Statewide Geohazards Viewer (HazVu)]

Using the OEM-FEMA Methodology (see page 2-99), the NHMP Steering Committee rated the county as having a **"high" vulnerability to the Cascadia Subduction Zone (CSZ) earthquake hazard**, meaning that more than 10% of the region's population or assets would be affected by a major CSZ emergency or disaster and a **"moderate" vulnerability to crustal earthquakes**, meaning that less than 10% of the region's population or assets would be affected by a major crustal earthquake emergency or disaster. *The previous NHMP also rated the earthquake vulnerability as "high" but did not distinguish between the crustal and CSZ events.* When Benton County representatives were asked to rank the relative vulnerability of Benton County residents to the two earthquake scenarios, they ranked vulnerability to a Cascadia Subduction Zone event as 6.9 out of 12 and vulnerability to a crustal event as 5.1 out of 12. Both of these are moderate rankings.

Vulnerability assessments reported in the 2016 plan included the following:

1999 special paper covering potential future losses in the state and can be found at this link [Special Papers: SP-29, Earthquake damage in Oregon Preliminary estimates of future earthquake losses (1999)]

2007 Rapid Visual Assessments of critical facilities that can be found at this link [RVS study] on DOGAMI's website (www.oregongeology.org).

> DOGAMI surveyed 43 buildings in Benton County. Many of the buildings identified at that time as being a 'high' or 'very high' potential for collapse have been retrofitted or rebuilt to current standards.

2008 regional earthquake damage assessment is available at this link Interpretive Map Series: IMS-024 - 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, 2008.

The following is a brief summary of damage and loss estimates for Benton County from that analysis in a magnitude 9.0 Cascadia Subduction Zone earthquake scenario:

- Estimated fatalities during late afternoon business hours: 120
- Injuries from minor to life threatening: 1,560
- Households displaced: 2,370
- People needing shelter: 660
- Injuries requiring hospitalization: 420

Note: Benton County has one hospital, Good Samaritan Regional Medical Center in Corvallis has *188 beds* with a *daily average* occupancy of *120 to 150. The hospital is expected to withstand earthquake impacts in the HAZUS M9.0 CSZ scenario*.

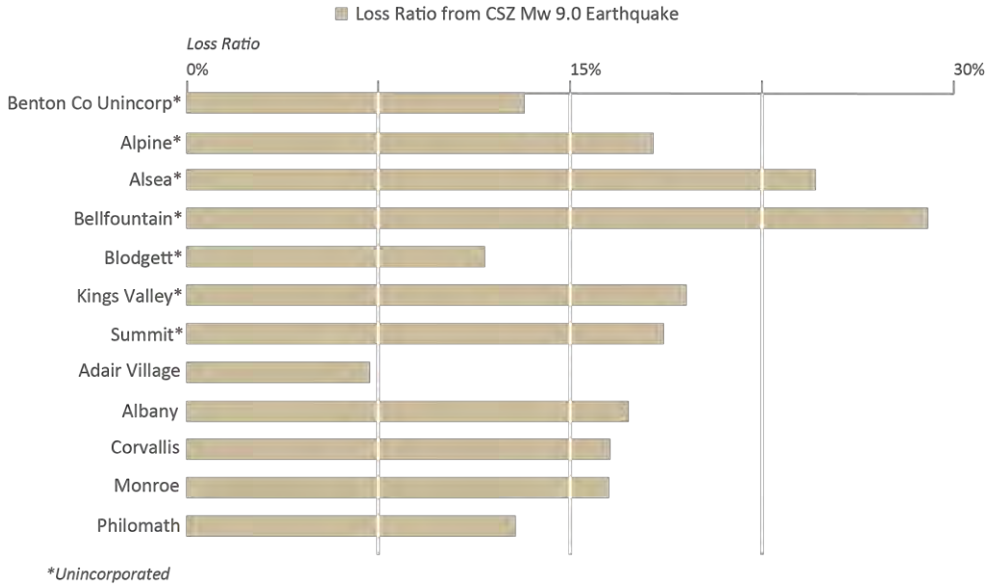
Risk Assessment

The 2023 DOGAMI Multi-Hazard Risk Assessment for Benton County uses the current best available data and modeling approaches to estimate damage to structures and displacement of people. This report is included in its entirety as an appendix to this plan and details from the plan are included in the risk assessment sections for each jurisdiction for which an annex was developed.

DOGAMI analyzed both a Cascadia Subduction Zone earthquake scenario and a crustal fault scenario in the vicinity of Benton County that could activate and cause damage in Benton County.

Using the FEMA modeling tool called Hazus-MH DOGAMI selected the deterministic scenario method because the CSZ event is the most likely large earthquake to impact this area. DOGAMI used the deterministic method to model a Mw 9.0 CSZ event along with the database of building attributes built for this analysis so that loss estimates could be calculated on a building-by-building basis.

Figure 15. CSZ Mw 9.0 earthquake loss ratio by Benton County community



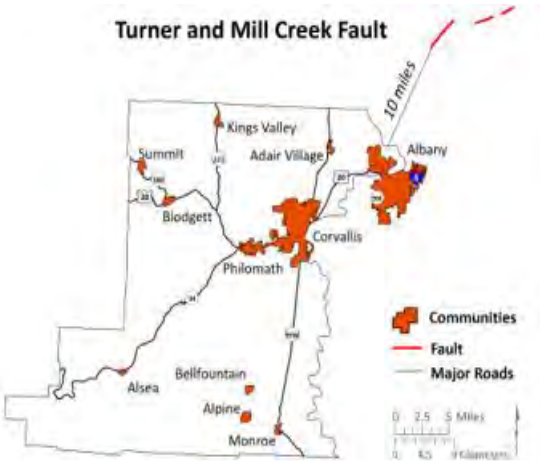
The results indicate that Benton County could incur moderate to significant losses (15%) due to a CSZ Mw-9.0 earthquake. Much of the damage is due to soils that amplify seismic shaking. The Willamette River and Marys River floodplains are composed of seismically reactive soils where the majority of the buildings in Benton County are located. Since these soils amplify ground shaking, the probability of earthquake damage is greater for structures built in these areas.

Benton County CSZ Mw-9.0 earthquake results:

- Number of red-tagged buildings: 2,553
- Number of yellow-tagged buildings: 8,936
- Loss estimate: $2,919,744,000
- Loss ratio: 15%
- Non-functioning critical facilities: 70
- Potentially displaced population: 9,505

The crustal fault examined for this report is the Turner and Mill Creek Fault, located approximately 10 miles northeast of Albany and oriented east to west (Figure 16). This is an ~11 mile (18 km) Quaternary fault estimated to slip less than 0.2mm/yr. Unlike CSZ, which is a very large and deep fault between two tectonics plates, the Turner and Mill Creek Fault is crustal, meaning it is a crack within the North American plate. Despite their comparatively small size, crustal earthquakes can cause significant damage due to their proximity to the surface and

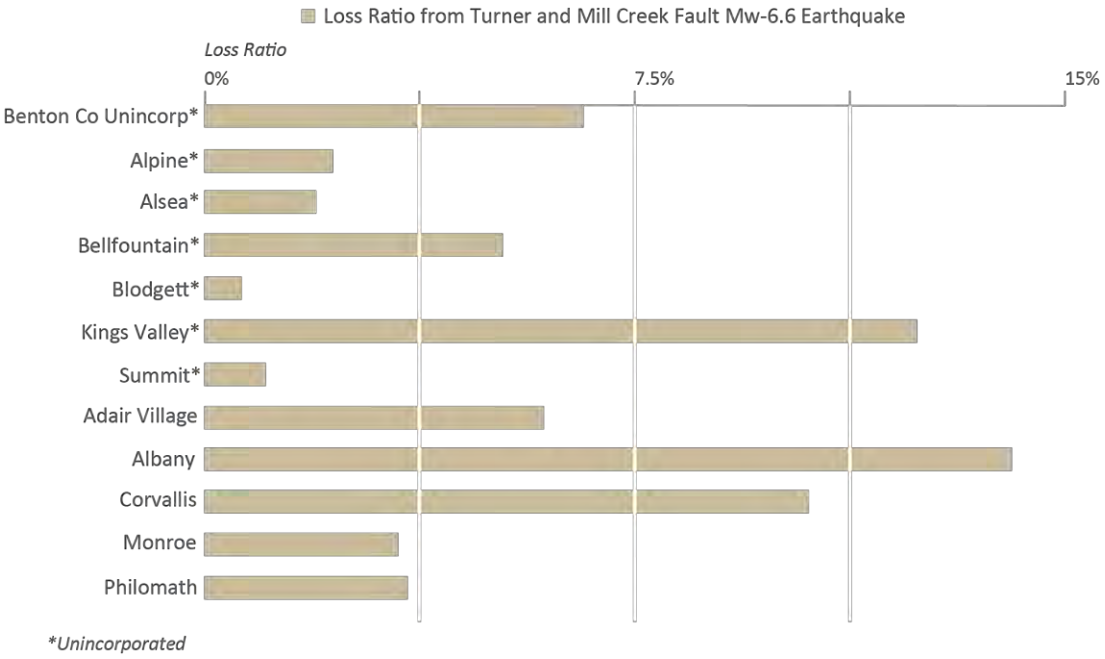
Figure 16. Turner and Mill Creek Fault



the built environment. The estimated maximum fault displacement for the Turner and Mill Creek Fault could produce relatively large (Mw-6.6) earthquakes, enough to pose a significant hazard (Personius, 2002). Although the damage produced from this fault would be far more localized than a CSZ event, it poses a serious seismic threat to the communities in the vicinity of the northeastern portion of Benton County. The current understanding of this fault and various aspects of its frequency and magnitude are limited.

DOGAMI's results indicate a Turner and Mill Creek Fault Mw-6.6 earthquake will cause significant damage (10% - 15% in losses) in the communities in the northeastern portion of the county. Because an earthquake can affect a wide area, it will also cause damage in the other communities in Benton County, but to a lesser degree. Figure 17 shows loss ratios from this earthquake scenario for the communities of Benton County.

Figure 17. Earthquake loss ratio from Turner and Mill Creek Fault Mw-6.6 by Benton County community



The results indicate that Benton County could incur losses near $2 billion or 10% of their total building assets from a Turner and Mill Creek Fault Mw-6.6 earthquake. These results are strongly influenced by the proximity of buildings to the epicenter of the simulated earthquake. Communities in the northeastern portion of the county are not only close to the epicenter, but also are in areas of highly liquefiable soils. In addition to proximity, liquefaction would exacerbate the level of risk from this earthquake scenario for the communities in this part of the county. DOGAMI reviewed the results in ArcMap and observed several residential buildings north of Corvallis and west of Highway 99W that have a high risk of damage from this earthquake due to coseismic landslide hazard.

Benton County Turner and Mill Creek Fault Mw-6.6 earthquake results:

- Number of red-tagged buildings: 1,898
- Number of yellow-tagged buildings: 5,956
- Loss estimate: $1,960,037,000
- Loss ratio: 10%
- Non-functioning critical facilities: 44
- Potentially displaced population: 6,774

Mitigation Successes[20]

The City of Corvallis and the City of Philomath have used two principal funding mechanisms to retrofit schools and fire stations to be seismically resilient.

Seismic retrofit grant awards by the Seismic Rehabilitation Grant Program[21] were made to retrofit the following buildings:

- Corvallis Fire Station #2 (2014 grant award, $300,896),
- Corvallis Fire Station #3 (2014 grant award, $300,896), and
- Philomath Fire Station (2014 grant award, $863,080).
- Philomath Middle School (2010-11 grant, $284,920)

These retrofits were completed in 2014.

The Benton County Sheriff's Office and Corvallis Police Department (Corvallis) was retrofitted in 1998.

Voter approved Facilities bonds supported structural and non-structure seismic retrofitting:

- Philomath Elementary School (bonded in 2010; completed between 2011-2015).
- Philomath High School (bond approved in 2010; completed between 2011-2015)
- Lincoln Elementary School (reconstructed in 2021)
- Adams Elementary School (2002 bond; retrofitted in 2008)
- Cheldelin Middle School (2002 bond; retrofitted in 2008)
- Garfield Elementary School (2002 bond; retrofitted in 2008)
- Kathryn Jones Harrison Elementary School, formerly Jefferson Elementary (2002 bond; retrofitted in 2008)
- Mt. View Elementary School (2002 bond; retrofitted in 2008)

The Corvallis School District 2018 Long Range Facilities Master Plan identified further seismic upgrades to Adams Elementary, Garfield Elementary, Jefferson Elementary (now Kathryn Jones Harrison Elementary), Mountain View Elementary, Cheldelin Middle, Crescent Valley High, and College Hill/Harding Center.[22]

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

[20] 2016 Benton County MNHMP update, page 2-15.

[21] The Seismic Rehabilitation Grant Program (SRGP) 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.

[22] CSD Long Range Facilities Master Plan – Approved 1/11/2018 CSD Long Range Facilities Master Plan - Approved January 11, 2018 - BoardBook Premier

Epidemic/Pandemic

Significant Changes Since Previous Plan:

Epidemic/Pandemic is being addressed for the first time.

Characteristics, Location and Extent

An epidemic is a disease that spreads and affects a large number of people within a community, population, or region.

According to the World Health Organization (WHO), a pandemic is the worldwide spread of a new disease. A pandemic occurs when a disease crosses from nation to nation, as opposed to only existing within one nation. Pandemics often spread across a large geographic area and can cause significant economic, social, and political disruption. Often, the disease that causes a pandemic can cause severe illness and spreads quickly from person to person. The severity of the illness may be higher during a pandemic due to the fact that the people the disease spreads to often have no pre-existing immunity to the new infectious agent.

History

Pandemics from recent history include:

- 1918 – 1920: H1N1 virus
- 1957 – 1958: H2N2 virus
- 1968–1969: H3N2 virus
- 2009–2010: Novel Influenza A H1N1, the virus that causes "swine flu"
- 2020: SARS (Severe Acute Respiratory Syndrome)-CoV-2, the virus that causes COVID-19 (coronavirus disease)

Other historical pandemics include The Black Death (1346–1350) and the sixth cholera pandemic (1899–1923).

Probability Assessment

The study in the Proceedings of the National Academy of Sciences used a newly assembled record of novel disease outbreaks over the past 400 years to estimate the intensity of those events and the yearly probability of them recurring.

It found the probability of a pandemic with similar impact to COVID-19 is about 2% in any year, meaning that someone born in the year 2000 would have about a 38% chance of experiencing one by now.

And that probability is only growing, which the authors say highlights the need to adjust perceptions of pandemic risks and expectations for preparedness.

"The most important takeaway is that large pandemics like COVID-19 and the Spanish flu are relatively likely," says coauthor William Pan, associate professor of global environmental health at Duke University. Understanding that pandemics aren't so rare should raise the priority of efforts to prevent and control them in the future, he says.

The analysis, which covered a murderer's row of pathogens including plague, smallpox, cholera, typhus, and novel influenza viruses, found considerable variability in the rate at which pandemics have occurred in the past. But they also identified patterns that allowed them to describe the probabilities of similar-scale events happening again.[23]

Based on the knowledge and experience of participants on the Benton County the NHMP Steering Committee, participants assessed the **probability of experiencing a pandemic or epidemic as high,** meaning one incident is likely within a 10 to 35 year period. This contrasts starkly with the research findings reported above. When Steering Committee members representing Benton County were asked to rank the relative probability of pandemic or epidemic from among the twelve hazards addressed in this plan, they ranked pandemic/epidemic at 7 out of 12, a moderate probability.

Vulnerability Assessment

FEMA developed a suite of materials to support recovery and preparedness for the effects of epidemic and pandemic disease. These including a database to detail Best Practice Case Studies found during the Coronavirus Emergency. These include case studies of materials to improve preparedness, and in particular the impact of potentially compounding effect of no-warning natural hazards like wildfire and severe weather.[24]

Vulnerability assessment in this FEMA guidance document includes aspects of operations during an event such as public messaging or sheltering during another natural disaster that displaces people from their homes. Disability considerations and connections to local food sources [25] are also aspects of vulnerability that should be addressed in planning for epidemic or pandemic events to meet the needs of at-risk individuals[26].

Using the OEM-FEMA Methodology (see page 2-99), the NHMP Steering Committee rated the county as having a **"high" vulnerability** to a pandemic or epidemic representing more than 10% of the population being affected. When Steering Committee members representing the county were asked to rank the relative vulnerability of Benton County residents to Pandemic/Epidemic, they ranked the hazard at 8.6 out of 12, in the highest third.

Extreme Heat

Significant Changes Since Previous Plan:

Extreme Heat is being addressed for the first time.

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[23] Proceedings of the National Academy of Sciences

[24] COVID-19 Best Practice Information: Natural Hazards Preparedness (fema.gov)

[25] COVID-19 Best Practice Information: Considerations for People with Disabilities (fema.gov)

[26] https://www.phe.gov/emergency/events/COVID19/atrisk/Pages/default.aspx

Characteristics

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

Table 3. Metrics and Definitions of Heat Extremes

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

Source: Future Climate Projections Benton County, Oregon, OCCRI, February 2023

Location and Extent

Extreme heat can refer to extremely warm daytime highs or overnight lows (days on which maximum or minimum temperatures are above a threshold or a probability relative to past decades), seasons in which temperatures are well above average, and heat waves, or multiple consecutive days on which maximum or minimum temperatures are above a threshold or a probability. In the Pacific Northwest, a day on which the maximum temperature is at least 90°F often is considered to be an extremely warm day. The number of such days increased significantly across Oregon since 1951 (O'Neill et al., 2023).[27]

History

In the period since 2016 there have been three extreme heat events in Benton County.

June 26-29, 2021: A high pressure heat dome over the region led to stretch of extreme heat, shattering records from June 26 through June 29. All time max temperatures were broken by 8 to 10 degrees. Widespread fatalities occurred due to the heat (123 in total), as

[27] Citations available in OCCRI's Future Climate Projections report included in the Appendices for this NHMP update.

many were without air-conditioning, as well as an increase in the number of drownings. Widespread closures and postponements of businesses and events also occurred. [28]

There were three consecutive days with maximum temperatures greater than 95 degrees measured at several weather stations, with two consecutive days greater than 100 degrees. The hottest day was on June 27 where temperatures peaked around 109 degrees and around 112 degrees in the Southern Willamette valley. Record breaking temperatures up to 111 degrees in Eugene, OR. There was one heat related death reported in the Southern Willamette Valley.

On July 29, 2021, a strong high pressure aloft brought a brief hot air mass to the region. The Oregon Governor issued an Emergency Declaration due to forecasted heat across the State affecting 23 counties.

August 11-12, 2021: Hot weather began to develop August 9, peaking August 11-12, but temperatures continued above normal into the weekend. Peak afternoon temperatures drove people to seek relief in or near bodies of water.

There were two consecutive days in the Southern Willamette Valley with maximum temperatures greater than 100 degrees. The hottest day was June 27 where temperatures in the area peaked around 112 degrees. Record breaking temperatures up to 111 degrees in Eugene, OR. There was one heat related death reported.

High Heat days on July 29, 2021, and August 18, 2021, bracketed this event with daytime temperatures in the high 90's and nighttime temperatures in the 60's.

August 17, 2022: High temperatures on the 17th were in the mid to upper 90s. For example, the high temperature near Eugene at Mahlon Sweet Field (KEUG) was 97 degrees. Overnight temperatures were quite warm with lows in the 60s.

Probability Assessment

Based on the participants' background and experience in Benton County the NHMP Steering Committee assessed the **probability of an extreme heat event as high,** meaning one incident is likely within a 10-to-35-year period. When Steering Committee members representing only Benton County were asked to rank the relative probability of extreme heat from among the twelve hazards addressed in this plan, they ranked extreme heat at 7.6 out of 12, a moderate to high probability.

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

The analysis is derived from 10–20 global climate models and two scenarios of future global emissions of greenhouse gases. The spatial resolution of projections from global climate models has been refined to better represent local conditions. County-level summaries of changes in climate metrics are projected to the beginning and middle of the twenty-first

[28] NOAA Storm Event database Event description; add link and proper citation.

century relative to a historical baseline. More information about the data sources is in the complete study included in this plan as Appendix H.

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

The number of days per year with temperatures 90°F or higher is projected to increase by an average of about 18 days (range 6–33 days) by the 2050s, relative to the 1971–2000 historical baselines, under the higher emissions scenario.

The temperature on the hottest day of the year is projected to increase by an average of about 6°F (range 2–9°F) by the 2050s.The average number of warm nights per year by the 2050's under the higher emission scenario is projected to be about 3 more than the average historical baseline of close to zero.

The table below shows the data indicating that under the higher emissions scenario, the temperature on the hottest day of the year is projected to increase by 1.5–8.7°F by the 2050s relative to the GCMs' historical baselines. The average projected increase in temperature on the hottest day is 5.9°F above the average historical baseline of 92.9°F. The average projected increase in temperature on the warmest night is 5.1°F above the average historical baseline of 61.5°F.

Under the higher emissions scenario, the numbers of daytime and nighttime heat waves are projected to increase by 0.9–3.8 and 0.0–1.1, respectively, by the 2050s relative to the GCMs' historical baselines. The average number of daytime and nighttime heat waves is projected to increase by 2.6 and 0.4, respectively, above the average historical baselines of 0.7 and zero.

Table 4. Change Number of Extreme Heat Days in Benton County

	Average Historical Baseline	2020s		2050s	
		Lower	Higher	Lower	Higher
Hot Days	4.4 days	4.2 days (1.7-7.9)	5.5 days (2.5-7.9)	10.8 days (5.4-18.6)	17.6 days (5.6-32.5)
Warm Nights	0.3 days	0.3 days (-0.1-1)	0.5 days (0-1.5)	1.3 days (0.1-3.8)	2.9 days (0.5-9.2)
Hottest Day	92.9°F	1.8°F (-0.2-3.1)	2.6°F (1-4.6)	4.4°F (1.4-6.6)	5.9°F (1.5-8.7)
Warmest Night	61.5°F	1.6°F (-0.2-3)	2.1°F (0.3-3.5)	3.8°F (1.9-6.2)	5.1°F (2.1-7.6)
Daytime Heat Waves	0.7 events	0.7 events (0.1-1.4)	0.9 events (0.4-1.4)	1.7 events (0.9-2.7)	2.6 events (0.9-3.8)
Nighttime Heat Waves	0 events	0 events (0-0.2)	0.1 events (0-0.2)	0.2 events (0-0.5)	0.4 events (0-1.1)

Source: Future Climate Projections Benton County, Oregon, OCCRI, February 2023

Vulnerability Assessment

Extreme heat can result in death due to heat stroke or when residents seek relief in bodies of water and can also result in malfunction of equipment not designed for those extremes.

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

Heat caused slowdowns on the MAX light rail in the Portland metro area, and some businesses closed due to the heat.

Using the OEM-FEMA Methodology (see page 2-99), the NHMP Steering Committee rated the county's residents as having a **moderate vulnerability** to an Extreme Heat event representing from 1-10% of the population being affected. When Steering Committee members representing the county were asked to rank the relative vulnerability of Benton County residents to an Extreme Heat, they ranked the hazard at 5.9 out of 12, a moderate ranking.

The OCCRI report also includes data on the potential effects of extreme heat on people. Certain populations are considered especially vulnerable to heat-related illness and death;

extreme heat also exacerbates interpersonal violence (Miles-Novelo and Anderson, 2019; Stechemesser et al., 2022). These populations include agricultural, forestry, and other outdoor workers; residents of urban heat islands; people with preexisting conditions or without housing or air conditioning; pregnant women; older adults; children; low-income communities; and communities of color (York et al., 2020; Ho et al., 2021).[29]

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

Flood

Characteristics

Most of Oregon's destructive natural disasters have been floods[30] typically occurring from November through April when storms from the Pacific Ocean bring intense rainfall. Flooding happens when rivers, streams, ditches and waterways overflow during high rain and storm events and when large amounts of snowmelt flow into rivers and streams.

Benton County flooding is most often caused by riverine floods, shallow area floods, and urban floods. The primary sources of riverine flooding in the county include the following rivers and their tributaries:

- **Willamette River** – This river forms the east border of Benton County.
- **Marys River** – Flowing from the northwest corner of the county, southeast to the Willamette River, this river passes the communities of Summit, Blodgett, and Wren as well as the cities of Philomath and Corvallis.
- **Tum Tum River** – This river is located in the northwest corner of the county, west of the community of Blodgett.
- **Luckiamute River** – Located at the north end of Benton County, this river passes through the communities of Hoskins and Kings Valley.
- **Alsea River** and **South Fork Alsea River** – These rivers are located in the southwest corner of the county and flow past the community of Alsea.
- **Long Tom River** – This river flows past the city of Monroe in the southeast corner of Benton County.

Location and Extent

Flood hazards 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 flood extent occurring in any given year.

[29] Citations available in OCCRI's Future Climate Projections report included in the Appendices for this NHMP update.

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

Flood events that have *magnitude* of "1-percent chance of occurrence in any given year" are used as the standard for most floodplain management in the United States. This flood magnitude is commonly referred to as the *100-year flood* or *base flood*.

The most readily available source of information regarding the 100-year flood is the set of Flood Insurance Studies and accompanying Flood Insurance Rate Maps (FIRMs) prepared by the Federal Emergency Management Agency (FEMA). These documents are used to support implementation of the National Flood Insurance Program. The FIRMs show 100-year flood hazard boundaries known as *Special Flood Hazard Areas* (SFHAs) and are the primary information source for flood insurance and floodplain management requirements. A digital version of the FIRMs is available through FEMA's National Flood Hazard Layer.[31]

Areas with significant development in the mapped floodplains include North Albany, North Corvallis, Corvallis (Dixon Creek Floodplain), Corvallis (Marys River Floodplain), the southern portion of Philomath, and the area southwest of Philomath between Greasy Creek and the Alsea Highway (US 34). Portions of the following smaller communities are also within FEMA-mapped floodplains: Alsea, Monroe, Blodgett, Summit, and Wren. For more information, refer to the current Flood Insurance Studies (FIS) and associated Flood Insurance Rate Maps (FIRM).

Historic Development of FIRMs in Benton County

The current FIRM mapping was developed through initial mapping performed by FEMA and the Army Corps of Engineers in 1970's. In the 1970s, FEMA mapped the 100-year and 500-year floodplains in Benton County and the Army Corps of Engineers mapped the 100-year floodplain for the Willamette and Marys Rivers. Additional flood insurance studies were created for Corvallis and Philomath (dated 1985 and 1981, respectively).

In 2008 FEMA updated the FIRM panels that became effective in 2011. Modifications included: combining the flood insurance rate maps and flood insurance studies for Benton County and incorporated cities into the countywide format; better topographic data was used where available, and letters of map revision were incorporated. In general, the 2011 update refined the edges of floodplains and revised the floodplain along Soap Creek, Dixon Creek (Corvallis), and the East Fork of Newton Creek (Philomath).

Since the 2011 FIS became effective, FEMA approved two Letters of Map Revision (LOMRs).

> The Philomath LOMR (Case No. 13-10-0260P) changed a large portion of the 100-year floodplain for the Marys River (lowering BFEs and adjusting edges) and significantly changed the West Fork Newton Creek 100-year floodplain.
>
> The Oak Creek LOMR (Case No. 14-10-0472P) made some significant changes to a section of Oak Creek (mostly within the City of Corvallis).

Effective in 2016, FEMA completed a major Physical Map Revision (PMR) of the North Albany area floodplains (both inside and outside of city limits in Benton County). The purpose of this revision was to incorporate updated analyses of the Thornton Lakes Overflow system and the Willamette River. FLO2D (Reference 1) was used to refine the floodplain mapping and BFE delineations on the west bank of the Willamette River from the

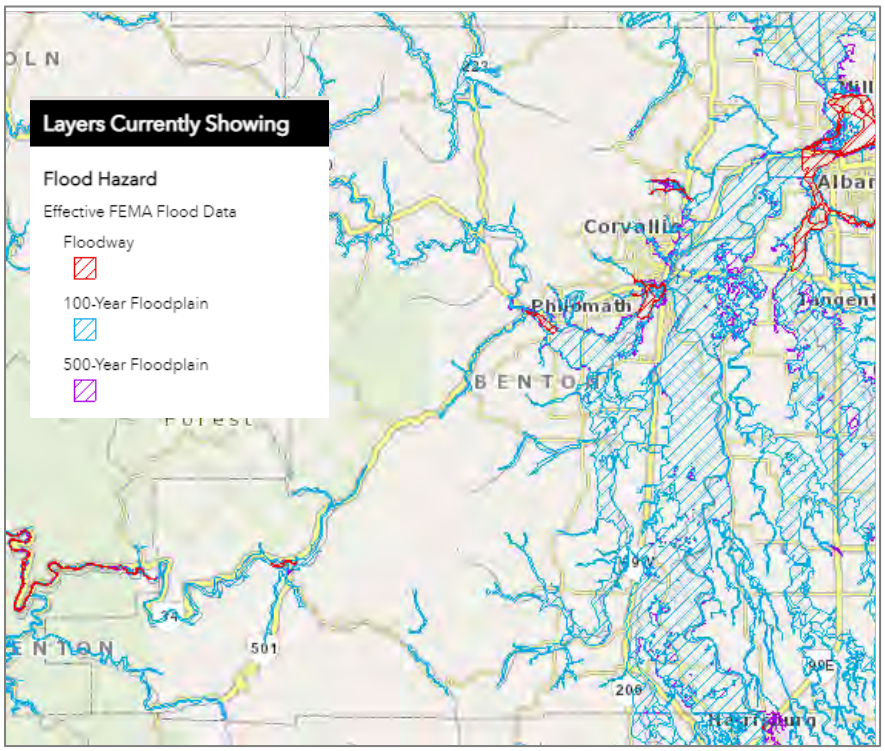
[31] FEMA's National Flood Hazard Layer (NFHL) Viewer (arcgis.com)

confluence with Thornton Lakes Overflow to approximately 2.2 miles upstream of the Southern Pacific Railroad. When the water surface elevation of the Willamette River near Mile 120.75 exceeds 193.45 feet (NAVD88), water reverses flow and enters several interconnected overflow paths that compose the Thornton Lakes Overflow system.

Base flood elevations were developed for reaches of Frazier Creek and Mountain View Creek; two watercourses located northeast of Corvallis. Refer to the following DOGAMI report for this study: BF-15-02 Base Flood Elevation Determination for Reaches of Frazier Creek and Mountain View Creek, Benton County, Oregon

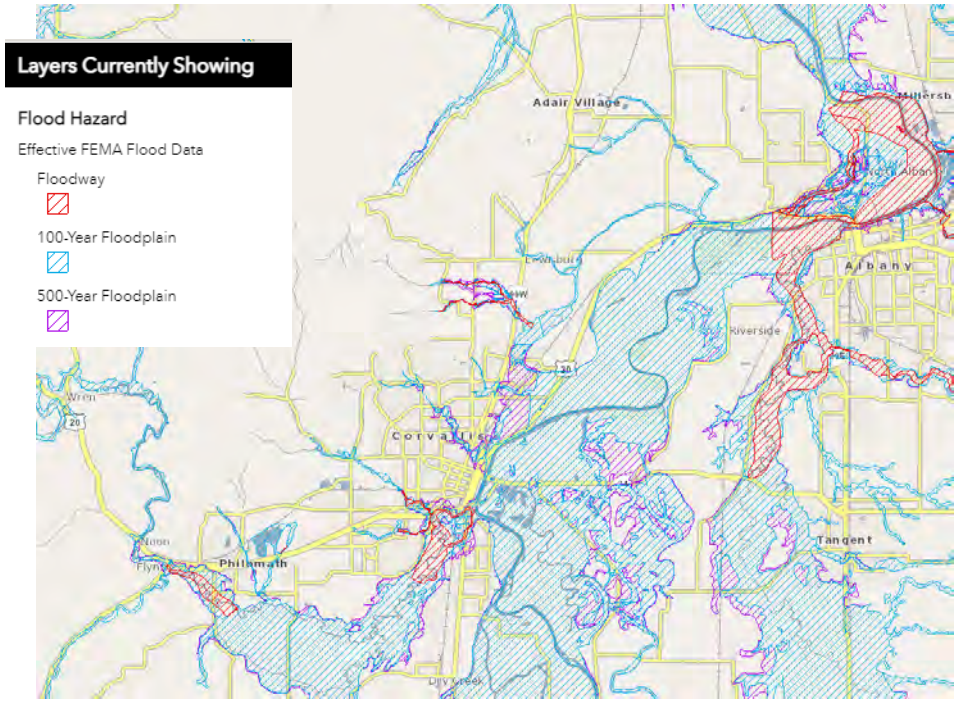
The current effective mapping of the Special Flood Hazard Area represents the location and extent of flooding as shown below for Benton County and for the Albany-Corvallis-Philomath area. For more detailed data represented in this mapping see the 2016 Flood Insurance Study.

Figure 18. Benton County Special Flood Hazard Area



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu)

Figure 19. Albany-Corvallis-Philomath Area Flood Map



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu)

The Benton County website maintains a webpage that provides floodplain hazard information including a link to the FEMA Map Service Center. Corvallis also maintains a page on the city's website that addresses floodplain development.

New flood studies

Two new studies are being performed by FEMA and the Army Corps of Engineers during this 2024 update.

The Federal Emergency Management Agency, US Army Corp of Engineers, Oregon Department of Geology and Mineral Industries, and Oregon Silver Jackets Team are working collaboratively with Benton and surrounding counties as well as the incorporated cities within the county on several projects to update flood and multi-hazard risk mapping in the Upper Willamette, Luckiamute, and Alsea watersheds. Current flood hazard remapping projects affecting Benton County include:

- Luckiamute Watershed
  Lead Agency: US Army Corps of Engineers – Portland District Floodplain Management Department
  In 2021 Benton County requested floodplain mapping assistance from the US Army Corps of Engineers, Portland District, (USACE) to update the mapped Special Flood Hazard Area of the Luckiamute River and tributaries within Benton County. To date, this work includes the following steps:
    - Field survey of the Luckiamute River in 2021.
    - Hydrologic analysis to understand how much water flows into the Luckiamute River.
    - Hydraulic analyses to compute a water surface profile along the river.

- Mapping of the 100-year flood hazard area, 500-year flood hazard area, and the floodway.

FEMA contributed revised flood hazard mapping data to the project for five Benton County tributaries that flow into the Luckiamute River. Benton County will use the results of this study to submit a request to FEMA for revision of the Flood Insurance Rate Maps for the Luckiamute River and selected tributaries.

A story map providing information about this project is available at: Mapping | Benton County, Oregon - Luckiamute Remapping (arcgis.com).

- Upper Willamette Watershed
  Lead Agency: Federal Emergency Management Agency Risk MAP[32] Team

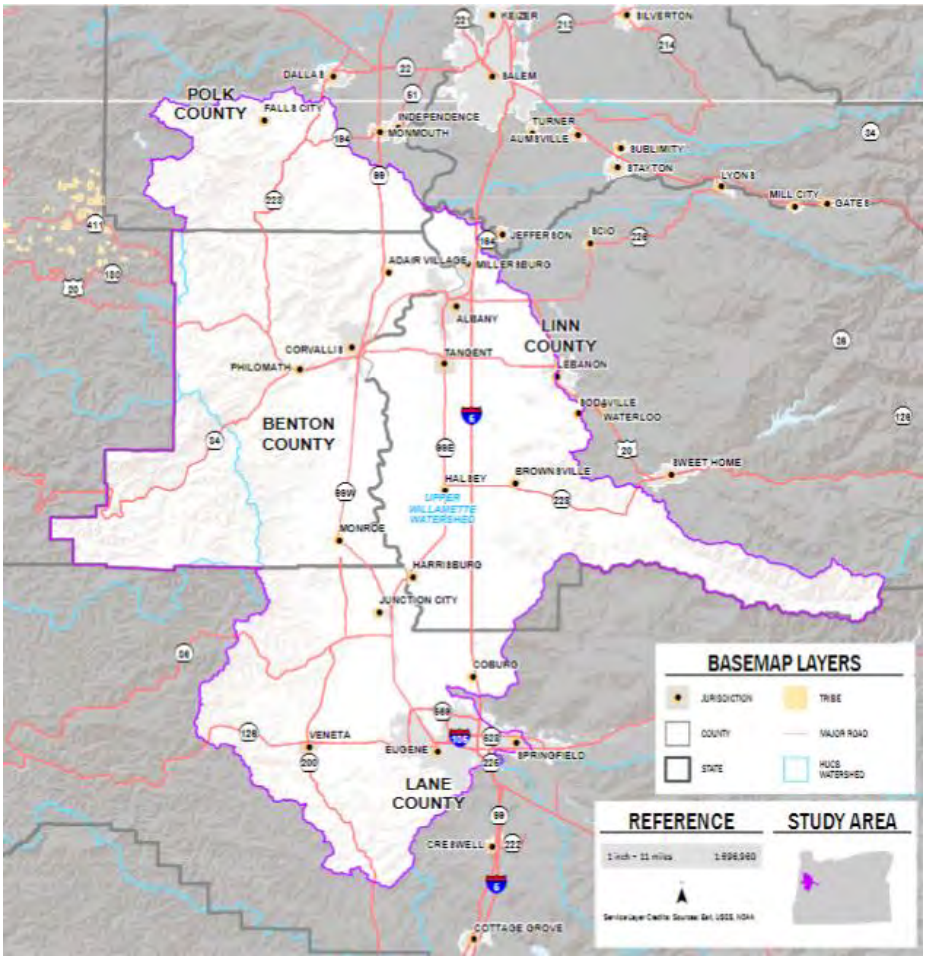
  FEMA's Risk MAP team completed the Discovery and Scoping phases, and is currently developing revised flood hazard maps for the Upper Willamette Watershed area in Benton and neighboring counties including portions of Lane, Linn, and Polk counties (see Figure 20). FEMA prioritized the Upper Willamette Watershed as a potential Risk MAP project area in 2020 based on community input involving a variety of considerations, including:

  1. Outdated and potentially incorrect hazard mapping,
  2. Existing and growing population density in potential high hazard areas, and
  3. Availability of high-quality elevation data to support new hazard mapping and analyses.

  A story map providing information about the results of the Discovery phase, the scope of flood studies to be completed, additional multi-hazard mapping and analysis projects funded through FEMA's Cooperative Technical Partners Program, and the progress of the Upper Willamette Watershed project is available at: Benton County, Oregon - Risk MAP Project (arcgis.com).

[32] Risk MAP: Risk Mapping, Assessment, and Planning

Figure 20. Upper Willamette Watershed Risk MAP Project Area



Source: Upper Willamette Watershed: Benton County Discovery Report, FEMA Region 10 Risk MAP

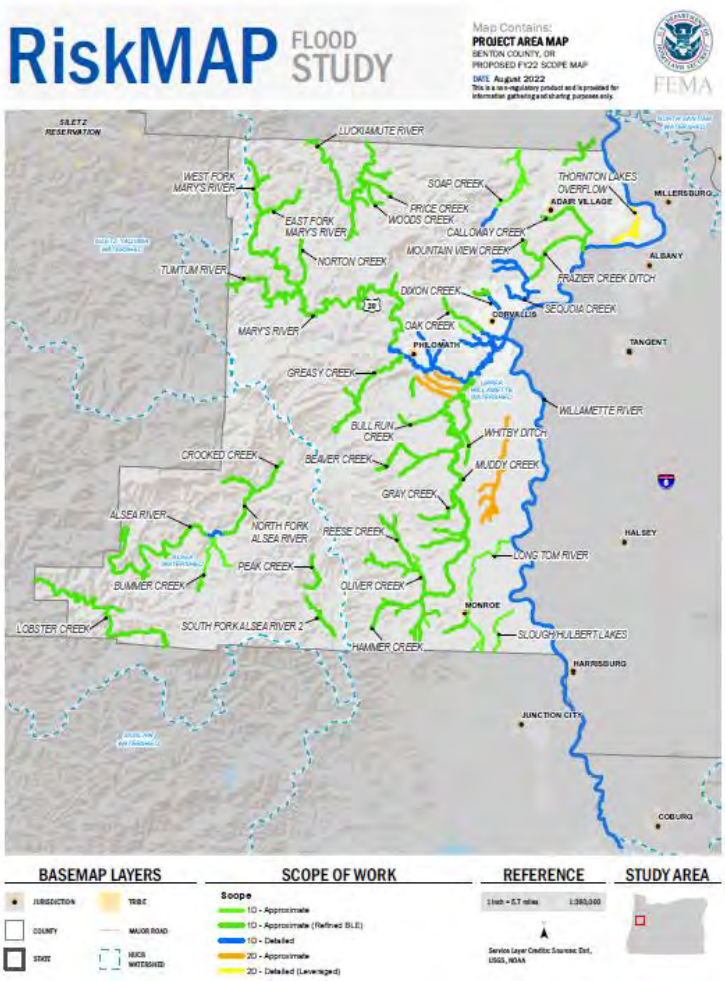
Additional hazards, insights, data, and potential projects are discussed in the Benton County Discovery Report. Areas of concern specific to flooding in Benton County are identified in Map 1 (included below as Figure 21) of the Discovery Report.

Figure 21. Benton County flood mapping highlights

1	Muddy Creek
2	Soap Creek Drainage/Lucklamute Drainage
3	Lucklamute River
4	Greasy Creek
5	Alsea River
6	Leisure Way and Cecil Lane
7	Llewellyn and US 99
8	Long Tom River
9	Major Highways
10	Marys River
11	Millpond Subdivision
12	Mountain View Creek
13	Norton Creek - Blodgett to Summit Area
14	Oliver Creek
15	Willamette River
16	Oak Creek

The project kicked off in October 2022 and current project activities include field surveying of 139 cross sections, 126 structures, and 28 structure measurements on the Willamette and the Marys Rivers. Engineering analysis is also taking place during the summer and fall of 2023 to provide 106.7 miles of enhanced AE analysis. This includes the Willamette River from 15 miles upstream of the Benton County limit at the confluence of the McKenzie River to downstream of Benton County at the confluence with the Santiam River. The project team proposes to complete 300 miles of Base 1-D steady-state hydraulic modeling using HEC-RAS on 82 reaches, 67 of which will leverage Base Level Engineering (BLE) analyses. BLE refinements will add multi-frequency flows, add structures, and resolve issues identified during BLE modeling. The project team proposes to complete 18.5 miles of Base 2-D unsteady-state hydraulic modeling using HEC-RAS on two groups of reaches both on the Marys River. The Flood Risk Review meeting is anticipated for Spring 2024.

Figure 22. Risk MAP Benton County Flood Study Project Area



History of Flooding

Between the 1850's and the present, human activity has significantly changed the hydrology of the Willamette watershed, including through construction of hydroelectric dams and flood control systems throughout the drainage basin. Private and public organizations engaged in the dewatering of wetlands, the draining of floodplains, and diking along some sections of the river. More recently, increasing urbanization has contributed to changes in basin hydrology. Prior to human alteration of the river system, rivers in the region flooded larger areas more often.

Stream gages along the principal rivers in the region allow determination of flood stage. According to the National Weather Service (NWS) flood stage on the Marys River at their gage near Philomath is 20.0 feet, and major flood stage is 20.7 feet; according to NWS records there have been 51 flood stage crests (including 17 major flood stages, the largest occurred on Jan. 19, 2012, at 21.53 feet) since 1938. Since the 2016 NHMP update there

have been three flood stage events on November 25, 2016 (21.21 ft), December 21, 2021 (20.95 ft), and January 3, 2022 (21.02 ft). [33].

Along the Willamette River at the Corvallis gage COR 03, flood stage begins at 30.0 feet, moderate flood stage at 33.0 feet, and major flood stage at 36.0 feet; there have been 26 flood stage events including 12 moderate and seven (7) high (the largest of which occurred on Dec. 1, 1861 reaching 42.4 ft)[34] Since the 2016 NHMP update there has been one flood stage event on April 10, 2019 where the Willamette at Corvallis crested at 32.84 ft.

Flood stage on the Long Tom River at Monroe is 9.0 feet (12.0 feet major flood stage); there have been 13 flood crests since 1964 (no major flood stage crests). Since the 2016 NHMP update there has been one flood stage event on April 9, 2019, where the Long Tom River crested at 9.11 ft.[35].

Listed below are historical flooding events that affected the Willamette and Marys River basins; little historical knowledge is available for the remaining streams within the study area.

Six significant flood events have been added since the previous plan (shown in *italics below*): [36]

- **Dec. 1861**: Willamette Basin and Coastal Rivers - Preceded by two weeks of heavy rain. Every town on the Willamette was flooded or washed away. 635,000 cfs at Portland (greatest known flood on Willamette River, prior to the creation of a stream-gaging network for recording flood heights).
- **Feb. 1890**: Willamette Basin and Coastal Rivers - Second largest known flood in the Willamette Basin. Almost every large bridge washed downstream.
- **Dec. 1937**: Western Oregon - Flooding followed heavy rains. Considerable highway flooding; landslides.
- **Jan. 1953**: Western Oregon - Widespread flooding in western Oregon accompanied by wind storm.
- **Dec. 1964 – Jan. 1965**: Willamette Basin - Highest recorded flooding throughout Willamette Basin. Two intense storms. Near-record early season snow depths. Largest flood in Oregon since dam construction on upper Willamette (1940s-50s); peak discharge of 320,000 cubic feet per second (cfs) was regulated to a peak of 186,000 cfs. Most damage in unincorporated Benton County was limited to agricultural lands, however, residential developments near Stewart Lake and North

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[33] National Weather Service, Advanced Hydrologic Prediction Service: Marys River near Philomath, http://water.weather.gov/ahps2/hydrograph.php?wfo=pqr&gage=phio3, Accessed March 13, 2023.

[34] National Weather Service, Advanced Hydrologic Prediction Service: Willamette River at Corvallis, http://water.weather.gov/ahps2/hydrograph.php?wfo=pqr&gage=coro3, Accessed March 13, 2023.

[35] National Weather Service, Advanced Hydrologic Prediction Service: Long Tom River at Monroe, http://water.weather.gov/ahps2/hydrograph.php?wfo=pqr&gage=mnro3, Accessed March 13, 2023..

[36] Benton County Flood Insurance Study (2011); Taylor, George and Raymond Hatton, 1999, The Oregon Weather Book; National Climatic Data Center Storm Events, Benton County Community Development Department.

Albany suffered extensive damage. Throughout the Willamette Valley, it caused $157 million in damages and 20 people lost their lives.

- **Jan. 1974**: Western Oregon - Flooding followed heavy wet snow and freezing rain. Nine counties received Disaster Declaration; Marys River basin recorded 4.42 inches of rain on Jan. 15, 1974. Severe flooding of area east of the Southern Pacific Railroad embankment to between 100 and 500 feet east of the millrace and in the area from Tunison Avenue to the Willamette River; damage to mobile homes, residences, and industrial buildings. (FEMA-413-DR-OR)
- **Dec. 1978**: Western Oregon - Intense heavy rain, snowmelt, saturated ground. One fatality in Benton County.
- **Feb. 1986**: Entire State - Severe statewide flooding. Rain and melting snow. Numerous homes flooded and highways closed.
- **Feb. 1987**: Western Oregon - Willamette River and tributaries. Mudslides damaged highways and homes.
- **Feb. 1996**: Entire State - Deep snowpack, warm temperatures, record-breaking rains. Flooding, landslides, power-outages. (FEMA-1099-DR-OR)
- **Nov. – Dec. 1996**: Entire State - Record-breaking precipitation; local flooding / landslides (FEMA-1107-DR-OR and FEMA-1149-DR-OR *did not include Benton County*). The flood on the Willamette River in Salem was recorded as a 44-year flood event. All highways surrounding Corvallis were closed due to flood water over the road (except for Highway 99W going north). Benton County Emergency Management stated that damage to Benton County residences was estimated at $1.2 million. FEMA-funded repair and response costs for eligible public entities totaled nearly $600,000. These costs were for Benton County, city of Corvallis, Corvallis School District and seven other FEMA-eligible applicants.
- **Dec. 2005 – Jan. 2006**: A very wet series of Pacific systems moved through northwest Oregon and southwest Washington dropping copious amounts of rainfall over the area. During the period of time, between 2-3 inches of precipitation fell over the Willamette Valley, and between 4-5 inches fell over parts of the Coast and Cascade Ranges. This period of heavy rainfall pushed many rivers above bank, and most of those above flood stage. Many roads around the area were reported closed due to high water, and road workers were busy battling several landslides.
- **Jan. 10, 2006**: Monroe and Philomath - A series of wet Pacific storms brought heavy rains to the area, causing flooding and damage. Low-lying areas and agricultural lands saw the most damage, while multiple road closures were due to flooding over local roads. Oregon Governor Ted Kulongoski declared a state of emergency in 24 of Oregon's 36 counties that included Benton County.
- **Jan. 17, 2006**: Corvallis, Monroe, and Philomath - A strong, moisture-laden storm brought heavy rains and flooding to northwest Oregon. Flooding affected widespread low-lying areas and agricultural lands. Flooding was also the cause of multiple road closures around the area.
- **Dec. 14, 2006**: Philomath - The Marys River near Philomath crested at 20.4 feet on the 15th; flood stage for this river is 20.0 feet.
- **Dec. 3, 2007**: Philomath - The Marys River flooded near Philomath, causing extensive flooding and flood damage in the City of Philomath and surrounding areas.
- **Jan. 1, 2009**: Philomath - Heavy rain combined with snowmelt runoff from the Coast Range and caused the Marys River to overflow its banks and flood the lowlands.
- **Jan. 2012**: Heavy rain, landslides, downed trees, roads closed included Highway

99W south of Corvallis, OSU closed for a day, delays for other school districts, 24-hour rainfall of over 4-inches. (FEMA-4055-DR-OR).

- **Dec. 2015**: Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides; Marys River reached flood levels, approximately 20 road closures in the county, downed trees and landslides. (FEMA-4258-DR-OR, Benton County not included)
- ***Nov. 25, 2016****: The Marys River near Philomath (PHIO3) crested at 21.21 feet, above major flood stage of 20.7 feet.*
- ***Feb. 9, 2017****: The Marys River near Philomath crested at 20.54 feet, above flood stage of 20.0 feet.*
- ***Apr. 9 – 11, 2019****: The Willamette River near Corvallis crested at 32.8 feet (2.8 feet above flood stage) and the Long Tom River near Monroe crested at 9.1 feet (0.1 foot above flood stage).*
  A particularly strong atmospheric river took aim for the south Willamette Valley, sitting over areas south of Salem for two days, producing anywhere from 2.5 to 5 inches of rain over a 48-hour period. Some areas in the Cascades and Cascade Foothills saw 5 to 7 inches of rain over that 48-hour period. Heavy rain combined with snow melt from all the snow from a few weeks prior in this same area caused flooding along most rivers in this area as well as along the main-stem Willamette River up to around Oregon City.

  This event was a federally declared disaster in Oregon – Severe Storms, Flooding, Landslides, and Mudslides FEMA-4452-DR – although Benton County was not among the designated counties.

- ***Dec. 21, 2020****: The Marys River near Philomath crested at 20.95 feet, above flood stage of 20.0 feet.*
- ***Jan. 14, 2021****: The Marys River near Philomath crested at 21.23 feet, above major flood stage of 20.7 feet.*
- ***Jan. 3, 2022****: The Marys River near Philomath crested at 21.0 feet, above major flood stage of 20.7 feet.*

Probability Assessment

The Federal Emergency Management Agency (FEMA) has mapped the 100- and 500-year floodplains, and in some areas the 10- and 50-year floodplains, in Benton County (see the Flood Insurance Study for more information). This corresponds to the following chances that these floods will occur during a one-year period:

- 10% – 10-year flood
- 2% – 50-year flood
- 1% – 100-year flood
- 0.2% – 500-year flood

The 100-year flood is the benchmark upon which the National Flood Insurance Program is based.

Based on the participants' background and experience in Benton County the Natural Hazard Mitigation Plan Steering Committee identified a **high probability** that residents will experience a flood event. On a 12-point scale, flood hazard probability was ranked as 9.9 for Benton County; this ranking represents an assumption that residents will experience at least

one flood event during a 10- to 35-year period. *This is the same rating that was assigned to the probability of flooding in the 2016 Benton County Natural Hazard Mitigation Plan*.

OCCRI's Future Climate Projections report for Benton County presents projected changes in four measures of precipitation and in flood magnitude.

Table 5. 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

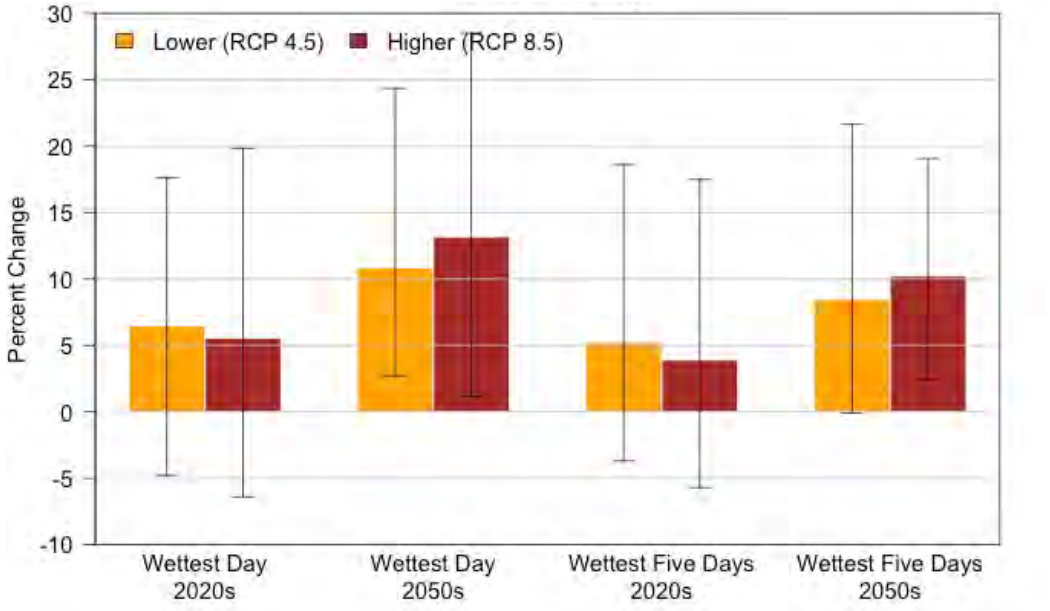
Source: Future Climate Projections; Benton County, Oregon; April 2023

OCCRI reports more uncertainty in projections of future precipitation than projections of future temperature. Precipitation has high natural variability, global models also treat atmospheric patterns differently making predictions less certain than those for future temperature. In the graph below, the length of the "whiskers" shows this natural variability and uncertainty in prediction.

Nonetheless, the OCCRI report projects increased intensity of extreme precipitation is expected as the atmosphere warms and holds more water vapor. In Benton County, the number of wet days per year is not projected to change substantially. However, the amount of rainfall on the wettest single day and the wettest five consecutive days is projected to increase as illustrated in Figure 23.

The wettest day over the historical baseline was 2.6 inches. Under the higher emissions scenario, the wettest day may rain 13.2% more or close to 2.9 inches. The wettest five consecutive days rained 6.5 inches based on the historical average. This could total 10.2% more by the 2050s totaling closer to 7.1 inches over the wettest five days.

Figure 23. Change in precipitation totals on wettest day and wettest five days in Benton County

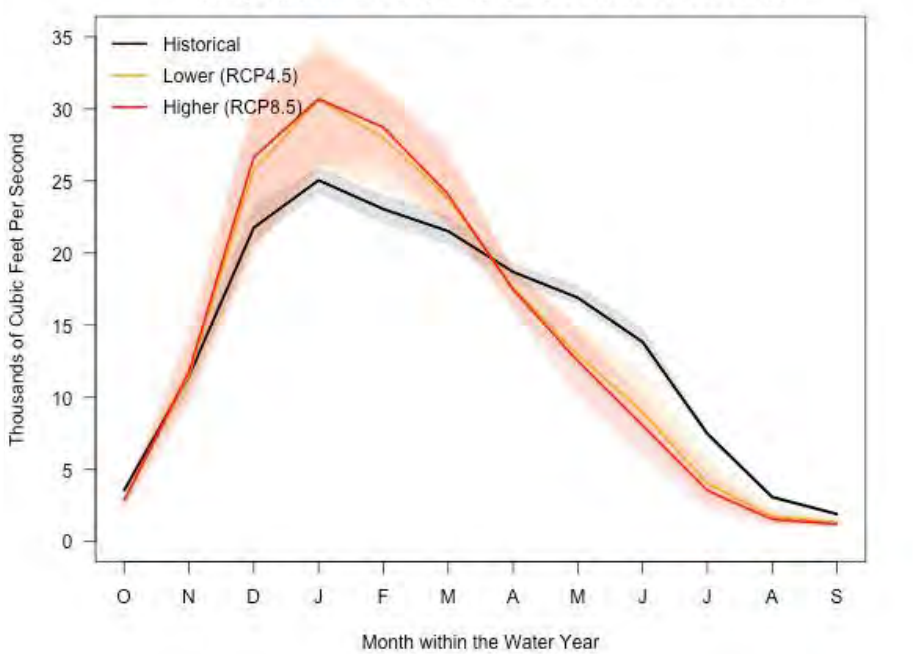


Source: Future Climate Projections; Benton County, Oregon; April 2023

With respect to future climate projections impact on flooding, OCCRI projects that streams in the Northwest are projected to shift toward higher winter runoff, lower summer and fall runoff, and earlier peak runoff, particularly in snow-dominated regions (Raymondi et al., 2013; Naz et al., 2016). These changes are expected as a result of increases in the intensity of heavy precipitation; warmer temperatures that cause more precipitation to fall as rain and less as snow, and snow to melt earlier in spring; and increasing winter precipitation and decreasing summer precipitation (Dalton et al., 2017, 2021; Mote et al., 2019).

The Willamette River at Albany is within a rain-dominated basin with peak flow during winter (Figure 24). By the 2050s (2040–2069), under both emissions scenarios, winter streamflow in the Willamette River at Albany is projected to increase due to increased winter precipitation. Winter streamflow at Rock Creek, a tributary of the Marys River, similarly is projected to increase (Rupp, 2019). Mean monthly flows do not translate directly to flood risk because floods occur over shorter periods of time. Nevertheless, 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 24. Willamette River at Albany
Monthly Streamflow Projections 2021-2070 vs. 1951-2000



Source: Future Climate Projections; Benton County, Oregon; April 2023

In summary, the analysis of precipitation and flooding in the OCCRI Future Climate Projections report supports the NHMP Steering Committee estimates of high probability of future flooding in the county.

Vulnerability Assessment

Using the OEM-FEMA Methodology (see page 2-99), the Natural Hazard Mitigation Plan Steering Committee rated the county's residents as having a **moderate vulnerability** to a flood event. Out of 12 potential hazards, flood was ranked as 8th; this ranking represents an assumption that 1-10% of the population will be affected by significant flood events. *This is the same rating that was assigned to flooding in the 2016 Benton County Natural Hazard Mitigation Plan*.

Benton County recognizes that changes to development patterns have the potential to increase the risk of flooding as well as the risk of damage to structures and impact to residents. Floodplain regulations for the unincorporated areas of Benton County restrict, and in some cases prohibit, new development in mapped flood hazard areas. This combination of encouraging and requiring location of new buildings in low-risk flood hazard areas:

- Reduces the risk of flood damage to future buildings,
- Reduces the risk to residents' safety and damage to their personal property,
- Reduces the impact of flood events on residents' daily lives and allows them to more quickly return to regular activities during and after flood events, and
- Maintains open flood hazard areas for storage of floodwaters, healthy wetland function, improved habitat health, and opportunities for agricultural and recreational

use.

The effectiveness of Benton County's current floodplain regulations is evidenced by the decreasing number requests for new development in mapped flood hazard areas. Since 2016, new development in these areas has been limited to a handful of agricultural structures commonly referred to as hoop houses. The remaining development activities – scattered throughout the unincorporated area of the county – are associated with already developed properties and existing structures. These activities have included a dozen replacement dwellings, a handful of bridge and park toilet replacements, and about two dozen small improvements and additions to existing dwellings.

Benton County flood hazard areas are generally located within the Willamette and Marys River basins and their tributaries, including the Long Tom River near Monroe. Additional flood hazard areas are located with the Alsea and Luckiamute River basins. Table 6 was created by the Department of Geology and Mineral Industries (DOGAMI) as part of that agencies Multi-Hazard Risk Assessment completed in 2022. The table summarizes DOGAMI's assessment of critical facilities – located in unincorporated Benton County and several unincorporated communities –risk from the impacts of flooding as well as the impacts of channel migration. The addenda for each city and the Hoskins Kings Valley RFPD are provided within each addendum.

Table 6. Critical Facilities in Unincorporated Communities and Unincorporated Benton County at risk of 1% annual chance flood and to a channel migration zone

Community	Critical Facilities	Flood 1% Annual Chance	Channel Migration Zone
		Exposed	Exposed
Unincorp.	Adair Village Sewage Treatment Plant	-	-
Unincorp.	Camp Adair	-	-
Unincorp.	Corvallis Locke Fire Station	-	-
Unincorp.	Corvallis Municipal Airport	-	-
Unincorp.	Corvallis Waldorf School	-	-
Unincorp.	Crescent Valley High School	X	-
Unincorp.	Flying Tom Landing Strip	-	-
Unincorp.	Muddy Creek Charter School	-	-
Unincorp.	Philomath Wastewater Treatment Plant	X	-
Alpine	Alpine Wastewater	-	
Alpine	Monroe Fire Department Station 2	-	
Alsea	Alsea School	X	X
Alsea	Alsea Rural Fire Protection District	-	X
Bellfountain	Monroe Fire Station 3	-	
Blodgett	Blodgett Elementary School	-	
Kings Valley	Hoskins-Kings Valley Rural Fire Protection District	-	-
Kings Valley	Kings Valley Charter School	-	
Lewisburg	Mountain View Elementary School	-	-
North Albany	Former Fir Grove Primary School, now Community Transitions	-	-
Summit	Blodgett-Summit Rural Fire Protection District Station 2	-	

Source: Based on tables in DOGAMI Multi-Hazard Risk Assessment

The flood loss estimation methodology consists of two modules that carry out basic analytical processes: flood hazard analysis and flood loss estimation analysis. The flood hazard analysis module uses characteristics, such as frequency, discharge, and ground elevation to estimate flood depth, flood elevation, and flow velocity. The flood loss estimation module calculates physical damage and economic loss from the results of the hazard analysis.

The communities of Alpine, Bellfountain, Blodgett, Kings Valley, and Summit are not exposed to risks to people and property from flooding based on the DOGAMI Multi-Hazard Risk Assessment that analyzed losses in the Special Flood Hazard Areas designated by FEMA or within channel migration zones identified by DOGAMI analysis. The unincorporated portions of rural Benton County and the unincorporated community of Alsea, however, are exposed to these risks as the following tables show.

Table 7. Hazard Profile for Unincorporated Benton County for flood and channel migration hazards

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Unincorporated Benton County (rural)		20,766	16,331		12	3,934,253,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	828	4.0%	842	2	34,480,000	0.9%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Channel Migration	Channel Migration Zone	258	1.2%	254	0	53,663,000	1.4%

[1]Facilities with multiple buildings were consolidated into one building complex.
[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Source: 2023, Williams and Calhoun, Open File Report O-23-06, Multi-hazard Risk Report for Benton County, Oregon

Table 8. Hazard Profile for Unincorporated community of Alsea for flood and channel migration hazards

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Alsea		216	137		2	30,315,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	17	7.7%	17	1	252,000	0.8%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Channel Migration	Channel Migration Zone	79	37%	50	2	16,937	56%

[1]Facilities with multiple buildings were consolidated into one building complex.
[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Source: 2023, Williams and Calhoun, DOGAMI Open File Report O-23-06, Multi-hazard Risk Report for Benton County, Oregon

More information on this hazard can be found in the DOGAMI Multi-Hazard Risk Assessment that is included in its entirety as one of the appendices to this NHMP update and also in the Risk Assessment for Region 3, Mid-Willamette Valley, of the Oregon NHMP (2020) or the most recent five-year update.

Landslide

Significant Changes Since Previous Plan:

The occurrence history for this hazard has been updated as well as the probability rating.

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.

Benton County is subject to landslides or debris flows (mudslides), especially in the Coast Range, which may affect buildings, roads, and utilities.

Additionally, landslides often occur together with other natural hazards, thereby exacerbating conditions, as described below:

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

Location and Extent

The characteristics of the geology and soils present in Benton County indicate the potential types of hazards that may occur. Rock hardness and soil characteristics can determine whether or not an area will be prone to geologic hazards such as landslides. The severity or extent of landslides is typically a function of geology and a landslide triggering mechanism such as heavy rainfall or earthquakes. 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.

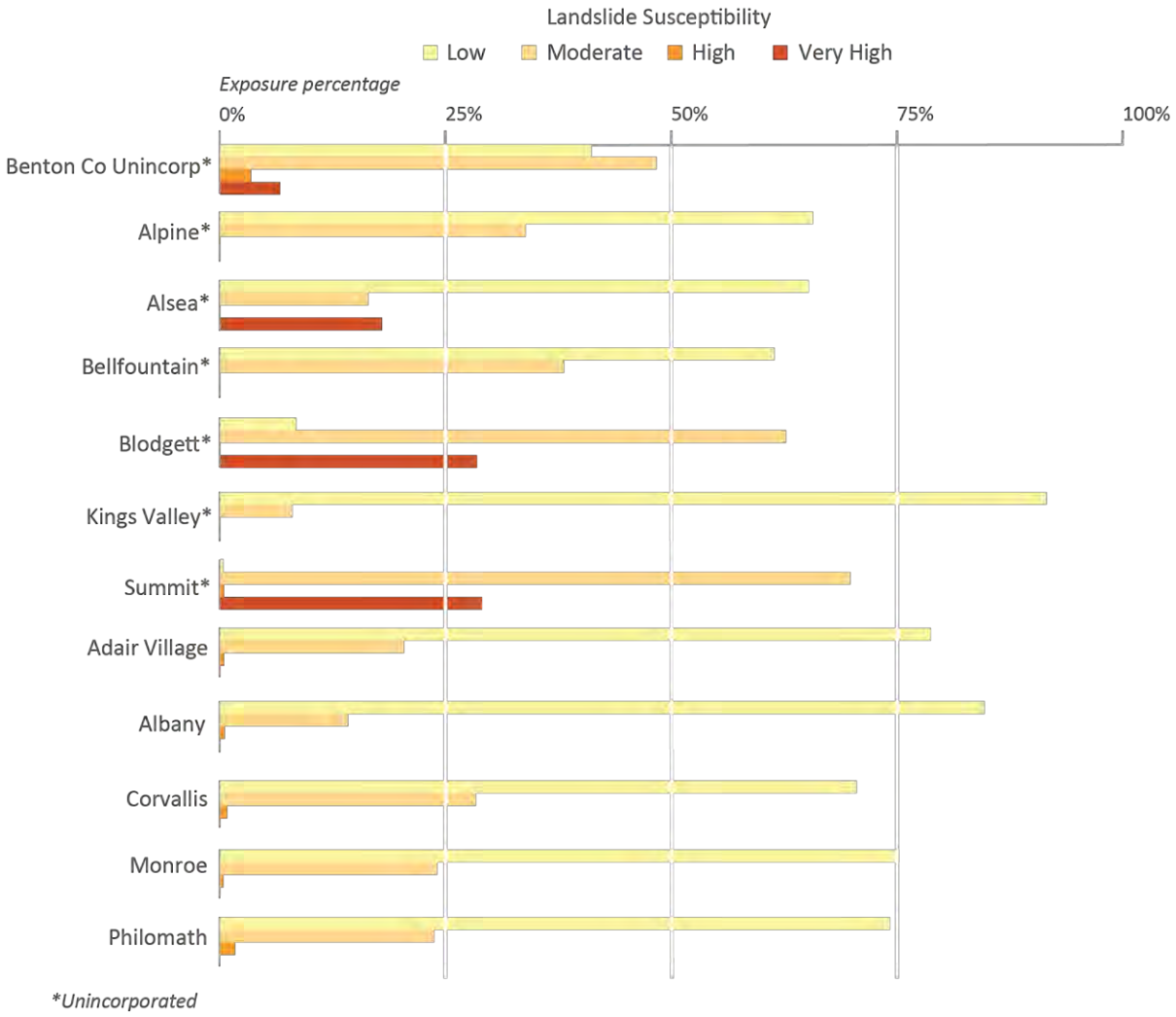
Landslide susceptibility mapping has improved over time as inventories based on lidar-derived topography form the basis for landslide feature mapping. The location and extent of landslides in Benton County were improved using these tools and those results are contained in DOGAMI's Multi-Hazard Risk Assessment for Benton County, Oregon, 2023.

The statewide susceptibility layer is an analysis of multiple landslide datasets. The Statewide Landslide Inventory Database for Oregon, or 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. 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.

Data sources used in this analysis include the data from the Statewide Landslide Susceptibility Map (Burns and others, 2016) and recent landslide inventory mapping in Benton County (Hairston-Porter and others, 2021) based on lidar-derived topography. DOGAMI's geologists and analysts used these data to identify the general level of susceptibility of given area to landslide hazards, primarily shallow and deep landslides.

Landslide susceptibility varies across Benton County as shown in the figure below.

Figure 25. Landslide susceptibility exposure by Benton County community



Source: 2023, Williams and Calhoun, DOGAMI Open File Report O-23-06, Multi-hazard Risk Report for Benton County, Oregon

The DOGAMI analyst overlaid building and critical facilities data on landslide susceptibility zones to assess the exposure for each community. The total dollar value of exposed buildings was summed for the study area and is reported below. DOGAMI analysts also estimated the number of people threatened by landslides.

The communities of Alpine, Bellfountain, and Kings Valley have no exposure to landslide, while the following sections of the Risk Profiles for rural Benton County, Alsea, Blodgett, and Summit show exposure ratios to landslide hazard ranging from 10% to 30% of total building value in these communities.

Table 9. Partial Risk Profile for unincorporated (rural) Benton County for landslide hazard

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Unincorporated Benton County (rural)		20,766	16,331		12	3,934,253,000	
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	2,516	12.1%	1,729	0	398,676,000	10%

Source: 2023, Williams and Calhoun, DOGAMI Open File Report O-23-06, Multi-hazard Risk Report for Benton County, Oregon

Table 10. Partial Risk Profile for unincorporated community of Alsea for landslide hazard

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Alsea		216	137		2	30,315,000	
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	66	30.5%	32	0	5,466,000	18%

Source: 2023, Williams and Calhoun, DOGAMI Open File Report O-23-06, Multi-hazard Risk Report for Benton County, Oregon

Table 11. Partial Risk Profile for unincorporated community of Blodgett for landslide hazard

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Blodgett		67	53		1	11,186,000	
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	36	53.7%	22	0	3,195,000	29%

Source: 2023, Williams and Calhoun, DOGAMI Open File Report O-23-06, Multi-hazard Risk Report for Benton County, Oregon

Table 12. Partial Risk Profile for unincorporated community of Summit for landslide hazard

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Summit		113	96		1	20,026,000	
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	40	35.7%	38	0	5,921,000	30%

Source: 2023, Williams and Calhoun, DOGAMI Open File Report O-23-06, Multi-hazard Risk Report for Benton County, Oregon

In general landslides and debris flows are possible in many of the higher slope portions of Benton County, including much of the western portion of the county. Landslide prone areas also include portions of the hilly areas west of Corvallis and limited portions of the North Albany area.

For Benton County, many high landslide potential areas are in hilly-forested areas. Landslides in these areas may damage or destroy some timber and impact logging roads. Many of the major highways in Benton County are at risk for landslides at one or more locations with a high potential for road closures and damage to utility lines. Especially in the western portions of Benton County, with a limited redundancy of the road network, such road closures may isolate some communities. In addition to direct landslide damages to roads and highways, affected communities are also subject to the economic impacts of road closures due to landslides, which may disrupt access to/egress from communities.

When planning development or site work in areas susceptible to landslide more detailed landslide hazard assessment requires a site-specific analysis of the slope, soil/rock and groundwater characteristics. Such assessments are often conducted by Certified Engineering Geologists to evaluate the specific hazard at the development site and to provide recommended methods for maintaining slope stability.

For more information, reports and maps about landslide hazard have been developed by DOGAMI and can be found by searching the department's publication list.

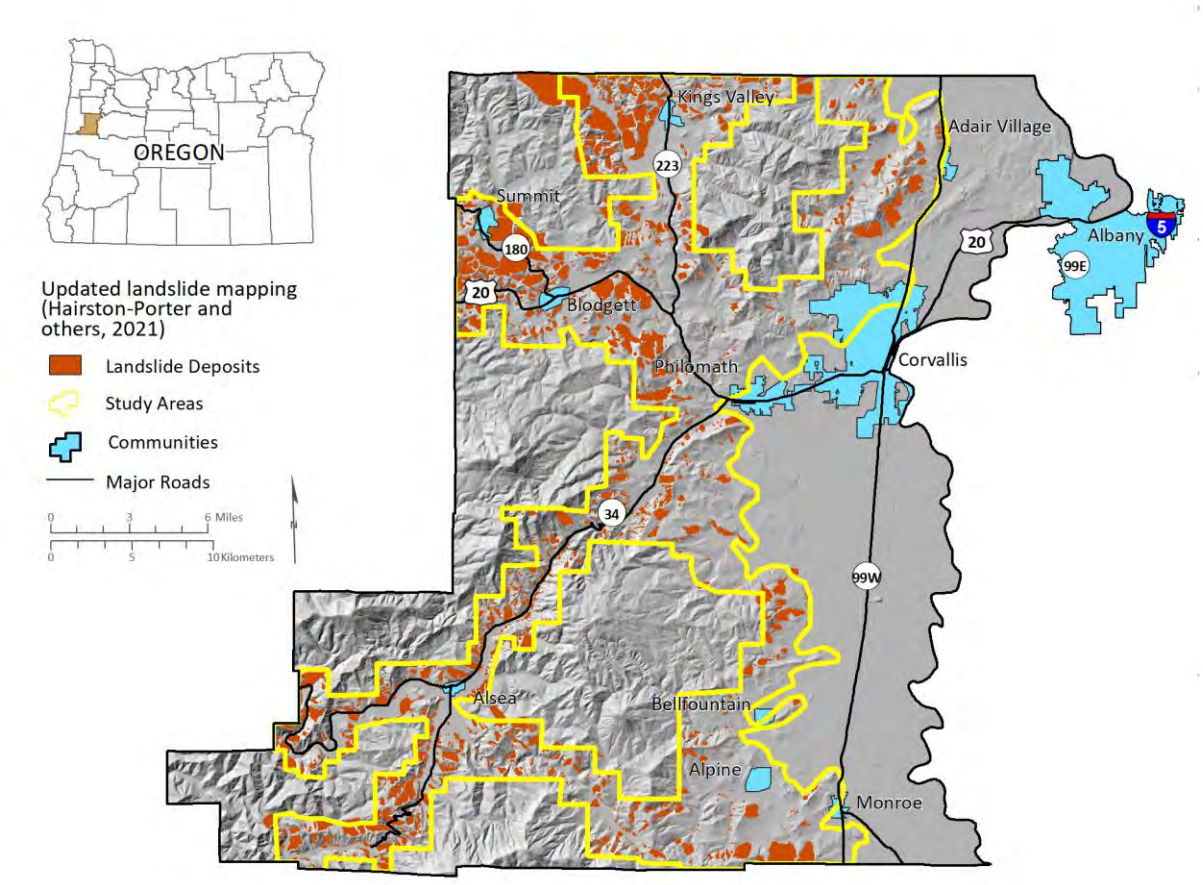
History

Landslides may happen at any time of the year. In addition to landslides triggered by a combination of slope stability and water content, earthquakes may also trigger landslides. Areas prone to seismically triggered landslides are generally the same as those prone to ordinary (i.e., non-seismic) landslides. As with ordinary landslides, seismically triggered landslides are more likely when soils are saturated with water.

Debris flows and landslides are a very common occurrence in hilly areas of Oregon, including portions of Benton County. Many landslides occur in undeveloped areas and thus may go unnoticed or unreported. For example, DOGAMI conducted a statewide survey of landslides from four winter storms in 1996 and 1997 and found 9,582 documented landslides, with the actual number of landslides estimated to be many times the documented number. For the most part, landslides become a problem only when they impact developed areas and have the potential to damage buildings, roads, or utilities. Figure 26 shows the landslide inventory

from recent mapping conducted based on lidar-derived topography for Benton County completed in 2021 by Hairston-Porter and others. For additional information see the Statewide Landslide Information Database for Oregon.

Figure 26. Recent landslide mapping in Benton County



Source: DOGAMI Multi-Hazard Risk Assessment for Benton County, Williams and Calhoun, 2023.

Below are listed the most severe landslide events, two (2) landslide event/s have been added since the previous plan (as shown in *italics* below):

- **Feb. 1996:** Entire State - Deep snow pack, warm temperatures, record-breaking rains. Flooding, landslides, power-outages. (FEMA-1099-DR-OR)
- **Nov. – Dec. 1996**: Entire State - Record-breaking precipitation; local flooding / landslides (FEMA-1107-DR-OR and FEMA-1149-DR-OR did not include Benton County). The flood on the Willamette River in Salem was recorded as a 44-year flood event. Benton County Emergency Management stated that damage to Benton County residences was estimated at $1.2 million. FEMA-funded repair and response costs for eligible public entities totaled nearly $600,000. These costs were for Benton County, City of Corvallis, Corvallis School District and seven other FEMA-eligible applicants.
- **Jan. 2012**: Heavy rain, landslides, downed trees, 24-hour rainfall of over 4-inches, there were 16 landslides in Benton County (FEMA-4055-DR-OR) including in the Vineyard Mountain area.

- **Dec. 2015**: Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides (FEMA-4258-DR-OR)

No landslides that required a response by road crews or emergency management were identified in Benton County for the period between 2016 and 2022.

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

Probability Assessment

The probability of rapidly moving landslides occurring depends on a number of 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). Given the correlation between precipitation / snow melt and rapidly moving landslides, it may be feasible to construct a probability curve for western Oregon. Recent work by DOGAMI to do that suggests that such correlations may require more data to provide a correlation with reasonable confidence limits.[37] Many slower moving slides present in developed areas have been identified and mapped; however, the probability and timing of their movement is difficult to quantify. The installation of slope indicators or the use of more advanced measuring techniques could provide information on these slower moving slides.

OCCRI's Future Climate Projections report assesses the impact of changes in precipitation patterns on the number of landslide risk days. By the 2050s under the higher emissions scenario, the average number of days per year in Benton County on which the landslide risk threshold is exceeded is projected to remain about the same. Landslide risk depends on multiple site-specific factors, and this metric does not reflect all aspects of the hazard. Also, the landslide risk threshold was developed for Seattle, Washington, and may be less applicable to other locations.

Based on the participants' background and experience in Benton County the NHMP Steering Committee assessed the **probability of future landslide occurrence is high,** meaning at least one incident is likely within the next 10- to 35-year period. *This rating has not changed since the prior plan update.* When Steering Committee members representing Benton County were asked to rank the relative probability of landslide from among the twelve hazards addressed in this plan, the participants ranked the probability of future landslides 6.4 out of 12, a moderate probability.

Vulnerability Assessment

Landslides can affect the structural integrity of buildings, utility services, transportation systems, and critical lifelines. 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.

[37] Bill Burns, DOGAMI, personal communication, June 2023.

Roads and bridges are subject to closure during landslide events. Because many Benton County residents are dependent on roads and bridges for travel to work, delays and detours are likely to have an economic impact on county residents and businesses. To evaluate landslide mitigation for roads, the community can assess the number of vehicle trips per day, detour time around a road closure, and road use for commercial traffic or emergency access. Particular vulnerabilities include major routes including Highway 20 and Highway 34.

Access to lifeline and critical facilities is essential 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. Inspection and repair of critical transportation facilities and routes is essential and should receive high priority for mitigation actions. Loss 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.

DOGAMI's quantitative landslide hazard analysis compared building locations to geographic extents of the landslide susceptibility zones. The exposure results shown below are for the high and very high susceptibility zones throughout the county.

Benton Countywide landslide exposure (High and Very High susceptibility):

- Number of buildings: 2,078
- Value of exposed buildings: $496,739,000
- Percentage of total county value exposed: 2.7%
- Critical facilities exposed: 0
- Potentially displaced population: 3,473

The report concludes as well that areas along Highway 20 and Route 34 west of Philomath have a high level of exposure to landslide hazard. Communities in terrain with moderate to steep slopes or at the base of steep hillsides may be exposed to landslides. Most of the developed land in Benton County is located on the gentle terrain found in the Willamette River Valley, which is predominantly classified as having a low landslide susceptibility. However, there are developed areas just north and west of Corvallis that are highly susceptible to landslide hazard. Landslide hazard is also ubiquitous in the western portion of Benton 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 Benton County.

Although landslide risk is present in some areas of the county, the Multi-Hazard Risk Assessment supports the Steering Committee's assessment of vulnerability to this hazard.

Using the OEM-FEMA Methodology (see 2-99), the NHMP Steering Committee rated the county's residents as having a **low vulnerability to landslide hazards**, meaning that less than 1% of the region's population or assets would be affected by a landslide. *This rating has not changed since the previous plan*. When Steering Committee members representing the county were asked to rank the relative vulnerability of Benton County residents to landslide, they estimated that the landslide ranked 4.6 out of 12 hazards for vulnerability, a low to moderate ranking.

More information on this hazard can be found in theDOGAMI Multi-Hazard Risk Assessment that is included in its entirety as one of the appendices to this NHMP update in the Risk Assessment for Region 3, Mid-Willamette Valley, of the Oregon NHMP (2020) or the most recent five-year update.

Volcano

Significant Changes Since Previous Plan:

There has not been any new data, or history, as such the material has remained largely the same.

Characteristics

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. A lahar is a violent type of mudflow or debris flow composed of a slurry of pyroclastic material, rocky debris and water. The material flows down from a volcano, typically along a river valley. Lahars are extremely destructive: they can flow tens of meters per second, they have been known to be up to 140 meters (460 ft) deep. Large flows tend to destroy any structures in their path.

Location and Extent

Volcanic eruption is not an immediate threat to the residents of Benton County, as there are no active volcanoes within the county. 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.

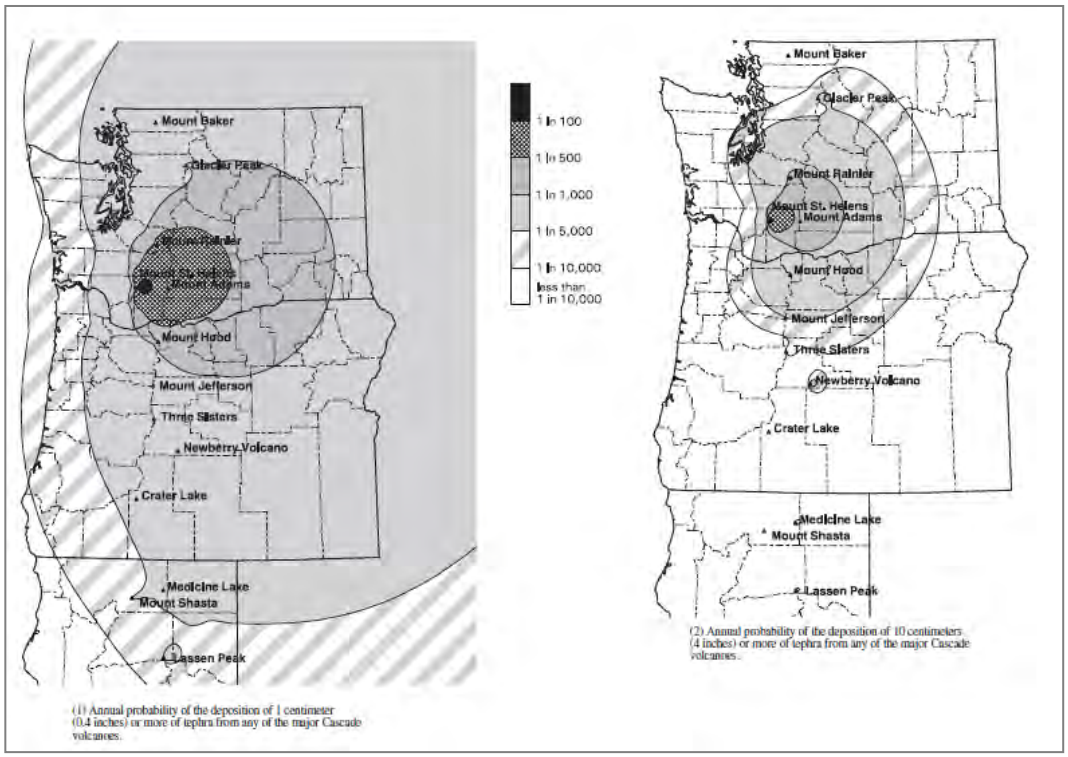
Volcanic activity is possible from Mount Hood and Mount Saint Helens, Three Sisters, Mount Bachelor, and the Newberry Crater areas. Because the distance to these potentially active volcanic areas is so great, the only adverse effect that would impact areas of Benton County is ash fallout, with perhaps some impact on water supplies. 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.

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.

Scientists use wind direction to predict areas that might be affected by volcanic ash; during an eruption that emits ash, the ash fall deposition is controlled by the prevailing wind

direction. The predominant wind pattern over the Cascades originates from the west, and previous eruptions seen in the geologic record have resulted in most ash fall drifting to the east of the volcanoes. Regional tephra fall shows the annual probability of ten centimeters or more of ash accumulation from Pacific Northwest volcanoes. Figure 2-9 depicts the potential and geographical extent of volcanic ash fall in excess of ten centimeters from a large eruption of Mt. St. Helens.

Figure 27. Regional Tephra-fall Maps



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

History

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

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

Probability Assessment

The United States Geological Survey-Cascades Volcano Observatory (CVO) produced volcanic hazard zonation reports for Mount St. Helens and Mount Hood in 1995 and 1997.

The reports include a description of potential hazards that may occur to immediate communities. The CVO created an updated annual probability of tephra (ash) fall map for the Cascade region in 2001, which could be a rough guide for Benton County in forecasting potential tephra hazard problems. The map identifies the location and extent of the hazard.

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

Based on the participants' background and experience in Benton County, the NHMP Steering Committee assessed the **probability of experiencing volcanic activity is moderate,** meaning one incident is likely within the next 75-year period. *This rating has not changed since the previous plan*. When Steering Committee members representing Benton County were asked to rank the relative probability of volcanic activity from among the twelve hazards considered in this plan, they ranked it least probable of all the natural hazards.

Vulnerabilities

Risks for Benton County 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.

At the time of this update, sufficient data was not available to determine volcanic eruption vulnerability in terms of explicit types and numbers of existing and future buildings, infrastructure, or critical infrastructure.

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 (e.g., Hood, St. Helens, or Adams) occurring during a period of easterly winds would likely have adverse consequences for the county.

Using the OEM-FEMA Methodology (see page 2-99), the NHMP Steering Committee rated the county's residents as having a **moderate vulnerability to volcanic activity**, meaning that between 1%-10% of the region's population or assets would be affected by ash fall from a volcanic event. *This rating has increased since the previous plan*. When Steering Committee members representing the county were asked to rank the relative vulnerability of Benton County residents to Volcanic Activity, they estimated that Volcanic Activity ranked 1.7 out of 12 hazards for vulnerability, a low ranking.

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

Wildfire

Significant Changes Since Previous Plan:

The occurrence history for this hazard has been updated as well as the probability rating since the 2016 plan update.-The 2016 Community Wildfire Protection Plan was updated in 2023 and is a primary reference for this section. Information about Senate Bill 762, the omnibus wildfire bill passed in 2021 that will result in statewide wildfire mapping, is included in this update.

Characteristics

Wildfire (or wildland fire) is an unplanned fire that can have beneficial and harmful effects on human, historical, cultural, and ecological resources. Wildfires can reduce fuel loads, increase ecosystem health and functioning, and restore fire-adapted ecosystems. At the same time, they can damage timber resources and soils, degrade water quality, and impair watershed functions. Wildfires also can damage communities, destroy homes, and lead to loss of human life.[38]

The characteristics of fire are important to understand when trying to mitigate its negative effects on humans and structures. In order for fire to exist, the three components of the fire triangle must be present. The triangle consists of fuel, heat, and oxygen. Most fires caused by natural events are initiated by lightning strikes. Human-caused fires, both accidental and deliberate, are produced in many ways, including campfires, chimneys, torches, matches, fireworks, cigarettes, vehicle fires, military ordnance, equipment usage, and smoldering slash piles. In either instance, natural or human-caused, the ignition is started because the fire triangle exists. [39]

[38] Benton County 2022 Community Wildfire Protection Plan

[39] Ibid.

Fire occurring in natural ecosystems begins as a point of ignition, burns outward into circles and spreads in the direction toward which the wind is blowing. Additionally, when burning occurs on uneven terrain the fire spreads upslope and will form itself into broad ellipses. Effects of fire on ecosystem resources can represent damages, benefits, or some combination of both, depending largely on the characteristics of the fire site, the severity of the fire, the period of valuation, and the values placed on the resources affected by the fire. [40]

The ecosystems of most forests depend upon fire to maintain various functions. The use of fire for beneficial purposes is considered, where appropriate, in terms of reducing fuel loads, disposing of slash, preparing seedbeds, thinning overstocked stands, increasing forage plant production, improving wildlife habitats, changing hydrologic processes, and improving aesthetic environments. However, despite its beneficial values to ecosystems, fire has been suppressed for years because of its perceived effects on timber harvest and threat to human life. In addition, new development continues to push its way into what is termed the "wildland-urban interface" (WUI), or interface.[41] The wildland-urban interface is the geographic area where structures and other human development meets or intermingles with wildland or vegetative fuels. It can be thought of as a transition zone between wildlands and human communities.

Senate Bill 762 (SB762) required Oregon State University to develop a statewide map of the wildland-urban interface (WUI). which, in conjunction with the statewide wildfire hazard and resulting risk to structures and other human developments map will be used to inform policy actions detailed in SB762 and subsequent legislation.[42]

State law says that in Oregon the WUI boundary is defined by areas within an Urban Growth Boundary, or any area with a building density of at least one building per 40 acres. The WUI is also defined by the density and proximity of wildland and vegetative fuels ("fuels"). By including density and proximity of fuels in the definition of the WUI, the urban core is excluded, and the focus is placed on those areas with sufficient building density and sufficient fuels to facilitate a WUI conflagration.

Scientists at OSU classified the wildfire hazard for all tax lots in Oregon into one of five classes: no, low, moderate, high, or extreme wildfire risk. Wildfire risk is a function of the three components of the wildfire risk triangle: burn probability, fire intensity, and the susceptibility of structures and other human developments. Annual burn probabilities are primarily a reflection of regional climate patterns and vegetation types, but can be affected by land use, ignition patterns and other elements that are within human control.

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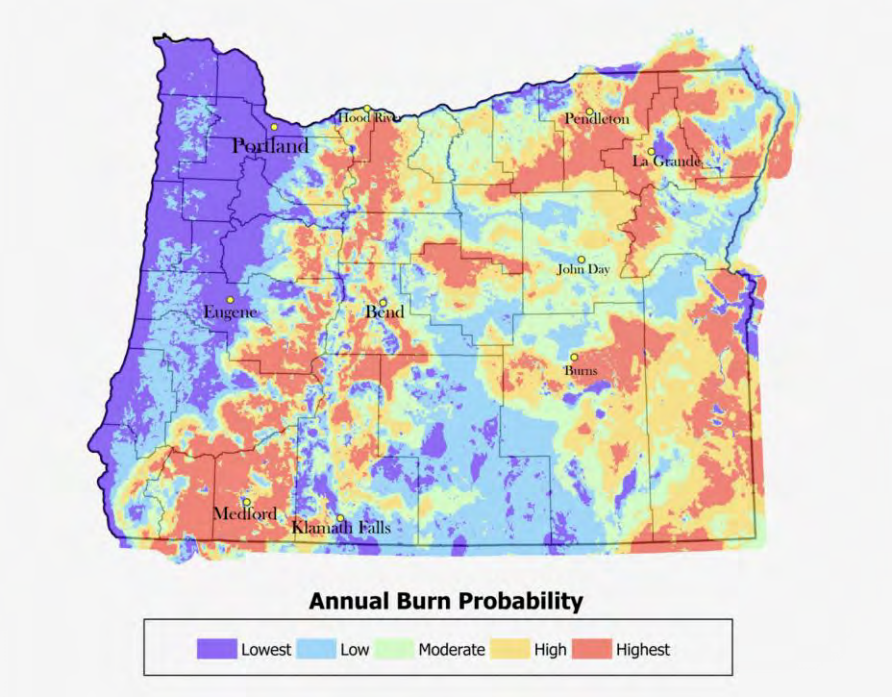
[40] Ibid.

[41] Benton County 2022 Community Wildfire Protection Plan

[42] On Aug. 4, 2022, the wildfire risk map that was released on June 30, was temporarily withdrawn for further refinement. These refinements will incorporate feedback from more than 2,000 Oregonians received during the recent public engagement process from in-person and online sessions around the state.

Figure 28. Modeled Annual Burn Probability



Source: [Mapping Wildfire Risk to Structures and Other Human Developments | OSU Wildfire Risk Mapping (oregonstate.edu)]

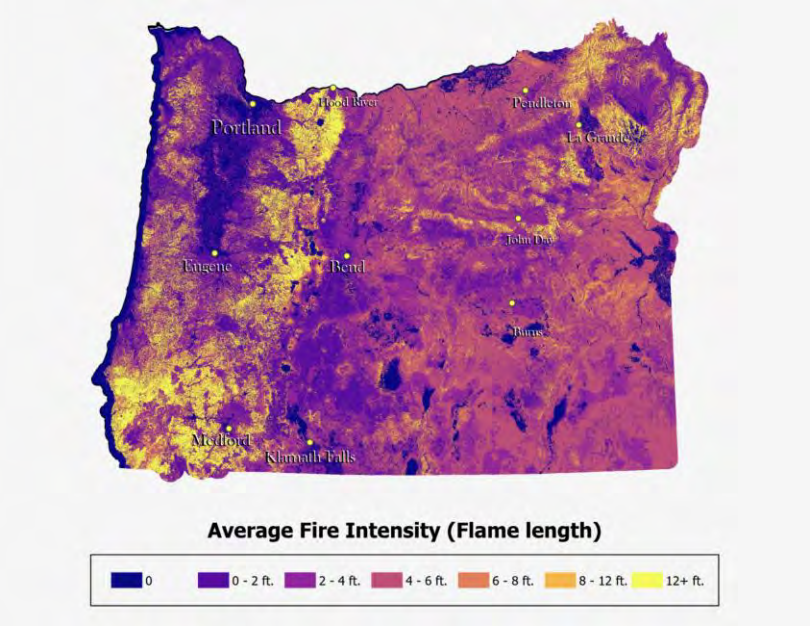
Wildfire intensity is a measurement of the amount of energy produced by a fire, frequently reported as "flame length." Fire intensity is driven by a number of factors including weather, topography, and fuel type.

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

Fuel: The type and condition of vegetation plays a significant role in the occurrence and spread of Wildfires. Certain types of plants are more susceptible to burning or will burn with greater intensity. Dense or overgrown vegetation increases the amount of combustible material available to fuel the fire (referred to as the "fuel load"). The ratio of living to dead plant matter is also important. The risk of fire 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.

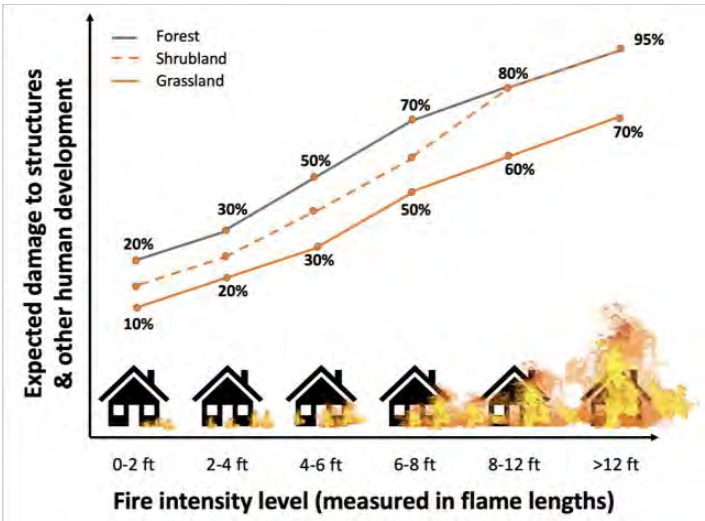
Figure 29. Modeled Fire Intensity



Source: [Mapping Wildfire Risk to Structures and Other Human Developments | OSU Wildfire Risk Mapping (oregonstate.edu)]

The estimated damage to a structure is directly related to the expected intensity of a wildfire and the kind of vegetation in which it's burning. OSU scientists identified the expected damage as "susceptibility," and it is measured using response functions as shown in the figure below. For instance, if a fire is burning in forested vegetation and the flame length at the location of a structure is five feet, the response function is 50, meaning that the building is expected to suffer a 50% loss in value.

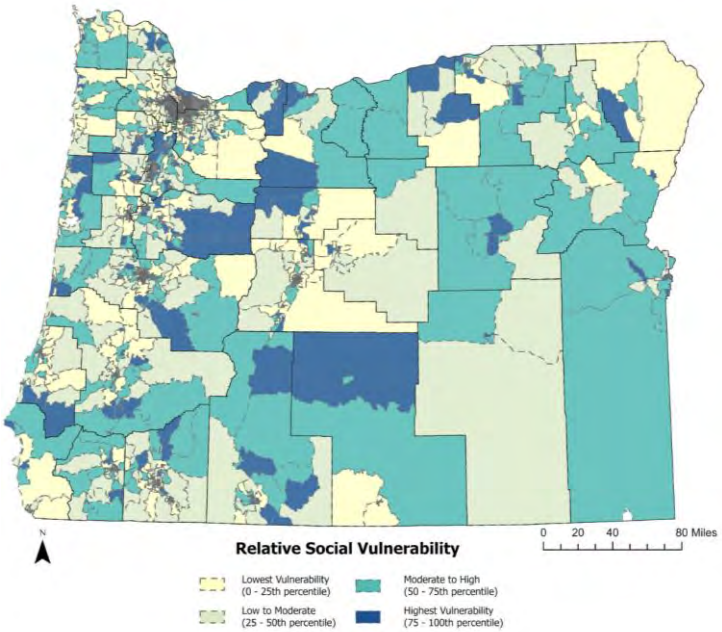
Figure 30. Expected damage by wildfire



Source: [Mapping Wildfire Risk to Structures and Other Human Developments | OSU Wildfire Risk Mapping (oregonstate.edu)]

Another aspect of wildfire risk, social vulnerability, was also mapped to illustrate how wildfire exposure and loss do not affect all communities equally. Wildfires disproportionately impact Oregon's most vulnerable communities. OSU created a social vulnerability index (SVI) to quantify and map vulnerability across Oregon. The map will be used to direct state resources to communities most in need of assistance in preparing for wildfires.

Figure 31. Relative Social Vulnerability map for wildfire



Source: Social Vulnerability | OSU Wildfire Risk Mapping (oregonstate.edu)

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.

Benton County's first Community Wildfire Protection Plan was approved by the Board of Commissioners in June of 2009, following a year-long public review process that included agency collaboration, public workshops at various county locations and solicitation of public input.

In October of 2016, an update of the CWPP was approved by the Board of Commissioners. This update was the result of a collaborative process involving agencies and individuals with

expertise and experience in wildfire issues, and includes current new data, a description of major accomplishments, and emergent issues.

The county's new 2023-2028 Community Wildfire Protection Plan is a primary reference for the consideration of wildfire mitigation in this NHMP. The Board of County Commissioners approved the Benton County CWPP on February 21, 2023. The approved plan can be found on the county's website at this link Community Wildfire Protection Plan | Benton County Oregon.

The 2023-2028 Benton County CWPP addresses Development as a factor in the behavior of wildfire. Currently, approximately 3,687 sq. mi. or 3.8% of Oregon's land base is considered to be WUI. These are areas where conditions are conducive to a large-scale wildland fire disturbance event, thereby posing a significant threat to human life or property. Using data from the Wildfire Risk Assessment tool, ODF estimated over 750,000 homes are located in WUI areas in Oregon. This percentage will change when the new statewide WUI mapping, undertaken by the State because of the passage of Senate Bill 762 (2021), is complete.

The 2023-2028 CWPP summarizes the impact of residential and other development on wildfire behavior that results in structures that are typically destroyed or damaged for one or more of the following reasons:

- Location in or surrounded by heavy fuel loads with a high degree of continuity (i.e. few significant firebreaks). Risk may be particularly high if the fuel load is grass, brush, and smaller trees subject to low moisture levels in short duration drought periods;
- Construction of structures to less than fully fire-safe practices: combustible roofing material, wood construction;
- Structures with no defensible space or lack of maintenance of defensible zones around structures;
- Storage of firewood and combustibles beneath or around structures;
- Poor road access to structures limiting firefighting apparatus;
- Structures located on steep slopes covered with flammable vegetation;
- Limited fire suppression capacity: limited water supply capacity for fire suppression purposes, limited firefighting personnel and apparatus, and long response times for fire alarms.[45]

Location and Extent

Wildfire hazard areas are commonly identified in regions of the Wildland Urban Interface (WUI). If left unchecked, it is likely that fires in these areas will threaten lives and property. One challenge Benton County faces is from the increasing number of houses being built in the urban/rural fringe as compared to twenty years ago. The "interface" between urban or suburban areas and the resource lands has significantly increased the threat to life and property from fires. Responding to fires in the expanding WUI area may tax existing fire protection systems beyond original design or current capability.

[45] Benton County 2022 Community Wildfire Protection Plan

The location and extent of 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 factors related to fire suppression/control, such as the surrounding fuel load, weather, topography, and property characteristics are incorporated into the burn probability aspect of wildfire risk mapping discussed above.

Fire susceptibility can change during the course of a year. Fire susceptibility 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 wildland fire. In addition, common causes of Wildfires include arson and negligence from industrial and recreational activities.

The Wildfire Omnibus Bill (SB 762) was adopted by the Oregon Legislature in 2021 and includes a requirement for ODF to collaborate with Oregon State University to develop a new Wildfire Urban Interface map. This effort has been delayed and when complete will provide an updated map of the WUI will replace the map below from the 2009 Benton County CWPP.

Based on the existing wildfire mapping of factors contributing to wildfire risk, the DOGAMI Multi-hazard Risk Assessment analyzed exposure to this hazard in Benton County. The following tables show these data for unincorporated Benton County both rural and within small communities in the county.

Table 13. Wildfire Exposure in Unincorporated Benton County

Wildfire Exposure Analysis Summary							
Community	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Benton County (rural)	High and Moderate Wildfire Risk	1,740	8.4%	1,172	0	250,624,000	6.4%
Alpine	High and Moderate Wildfire Risk	4	2.0%	2	0	291,000	1.1%
Alsea	High and Moderate Wildfire Risk	28	13%	18	1	3,683,000	12%
Bellfountain	High and Moderate Wildfire Risk	0	0%	0	0	0	0%
Blodgett	High and Moderate Wildfire Risk	4	6.0%	3	0	1,282,000	11%
Kings Valley	High and Moderate Wildfire Risk	0	0%	0	0	0	0%
Summit	High and Moderate Wildfire Risk	26	23%	20	1	6,884,000	34%

Source: DOGAMI Multi-Hazard Risk Assessment for Benton County, Oregon; O-23-06, Williams and Calhoun, 2023

History

Benton County has not directly experienced a large wildfire event in the last 20 years.

Oregon Department of Forestry recorded 48 fires from 2017-2022. Forty (40) of these fires burned less than 0.5 acres. Seven (7) of these fires burned between 0.5 and 5 acres. The

largest fire , the Norton East fire burned 17.8 acres one mile NE of Blodgett in a fire that began on August 17, 2022. All but one of these fires were human caused.

Near Alsea, the Yew Creek fire burned 2 acres in an area 5 miles NE of Alsea on September 7, 2020, the Maple fire burned 0.65 acres in an area 6.6 miles SW of Alsea on July 4, 2021, and earlier that year in April the Salmonberry fire burned 0.34 acres at a location 3.8 miles SW of Alsea.

Near Adair Village four small (0.01 acres burned) fires were recorded during the period from 2017-2022 in areas west and southwest of Adair Village.

Near Corvallis the largest fire during this time period, the Chinook fire burned 1.17 acres in an area 2 miles west of the city on April 24, 2018. One fire in North Corvallis (Cavalry fire) on July 9, 2018 and one 3 miles west of Corvallis (Sulphur Springs fire) on August 30, 2022 each burned 0.01 acres.

The largest fire that occurred near Monroe during this time period was the Anderson County Park fire that burned 0.9 acres on August 29, 2022. Two other smaller fires burned less than 0.2 acres west of Monroe on May 14, 2021 (Larson Creek), on July 5, 2019 (Green Pea Rd fire) and on October 25, 2018 (Buck Peak Fire).

Near Philomath the largest fire that occurred during this time period burned 0.17 acres on August 5, 2019 in an area 1.76 miles west of Philomath (Dorset Ln. fire), Only one other small fire was recorded by ODF during this period 8 miles NW of Philomath in August 2022 (Vincent Creek Fire).

Prior to this plan update, the 2016 Benton County MNHMP documented the Timberhill Fire which occurred in 2014. The ignition cause was arson and it charred 86 acres and a house near Chip Ross Park (Corvallis). The cost to suppress was more than $72,000. While the county is considered a low-risk fire area in relation to the entire state, there is always a possibility of localized factors causing greater wildfire susceptibility.

The oldest big fire event near Benton County was the Tillamook Burn from 1933 to 1951, which burned a combined total of 355,000 acres in the counties of Washington, Yamhill, and Tillamook north of Benton County. That fire was surpassed in size by the Santiam Fire which started as three separate fires that converged into one (Beachie Creek, Lionshead, and P-515 fires). The Santiam Fire burned 402,274 acres in Marion, Jefferson, Linn, and Clackamas Counties in August 2020. Ash from this fire fell on Benton County for weeks and smoke from the fire was a major health hazard for everyone.

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.

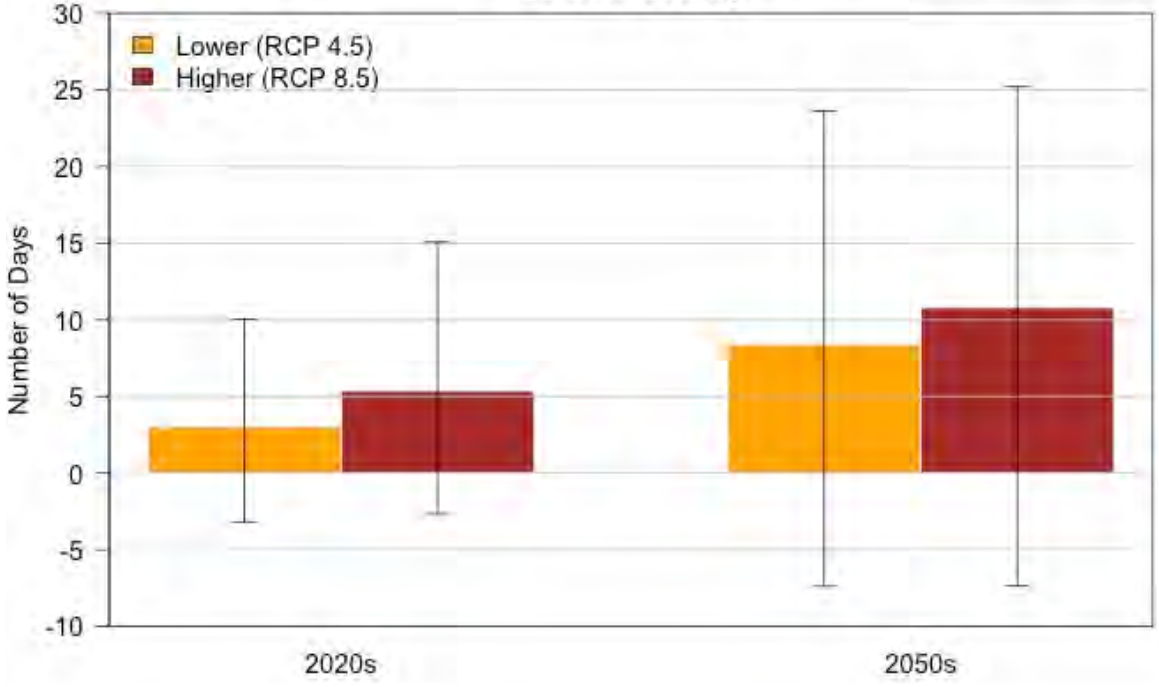
Based on the participants' background and experience in Benton County, the NHMP Steering Committee assessed the **probability of experiencing a Wildfire is high,** meaning

one incident is likely within the next 10- to 35-year period. *This rating has not changed since the previous plan*. When Steering Committee members representing Benton County were asked to rank the relative probability of Wildfire from among the twelve hazards considered in this plan, they ranked it 8.7 out of 12 natural hazards, in the top third.

OCCRI's Future Climate Projections for Benton County, Oregon provides an assessment of the potential for climate change to affect the probability of wildfire in Benton County. OCCRI's analysis estimates the future change in wildfire risk with two metrics, FM100[46] and Vapor Pressure Deficit (VPD)[47], that are proxies for extreme fire danger, or conditions under which wildfire is likely to spread.

The report presents projected changes in the average annual number of days on which FM100 is very high and VPD is extreme for two future periods, both of which we compare to the historical baseline (1971–2000 average), under two emissions scenarios. A day with very high fire danger is defined as one on which the FM100 value (moisture on the forest floor) is comparable to the lowest (driest) 10% of values within the historical baseline period (1971–2000). Historically, fire danger in Benton County was very high on 36.5 days per year. By the 2050s under the higher emissions scenario, the average number of days per year on which fire danger is very high is projected to increase by 11 (range -7–25) (Figure 32).

Figure 32. Change in Annual Number of Very High Fire Danger Days, Benton County, Oregon



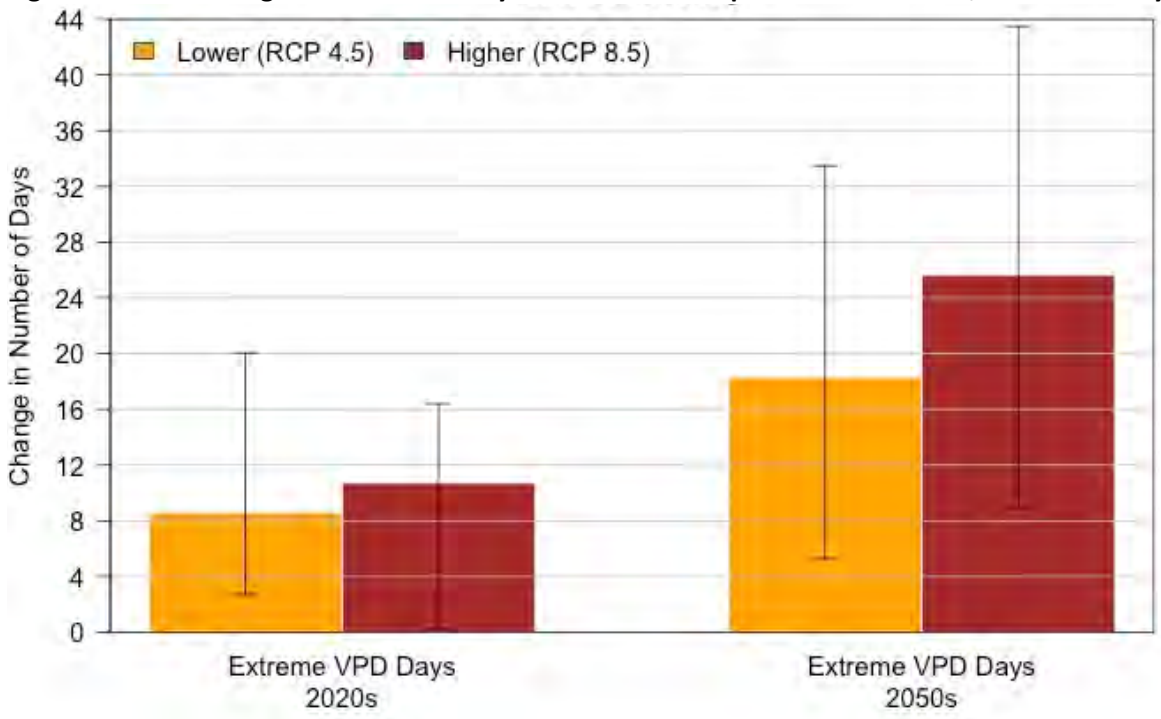
[46] FM100 is a measure of the percentage of moisture in the dry weight of dead vegetation with 1–3 inch diameter and is calculated from precipitation, temperature, and relative humidity according to the equations in the National Fire Danger Rating System (Bradshaw *et al.*, 1984).

[47] The dryness of the air, also called evaporative demand, is characterized by the vapor pressure deficit (VPD). The VPD is the difference in atmospheric pressure between the current amount of water vapor in the air and the maximum amount of water the air can hold at a given temperature (dew point).

Source: Future Climate Projections, Benton County; OCCRI, April 2023

Similarly, a day with extreme VPD (dry air) is defined as a day within the warm season (March–October) on which VPD is comparable to the highest (driest) 10% of values within the historical baseline period. Historically, VPD in Benton County was extreme for 24.5 days per year. Under the higher emissions scenario, the average number of days per year on which VPD is extreme is projected to increase by 26 (range 9–43) by the 2050s (Figure 33).

Figure 33. Change in Number of Days with Extreme Vapor Pressure Deficit, Benton County



Source: Future Climate Projections, Benton County; OCCRI, April 2023

This analysis supports the assessment of the Benton County Steering Committee.

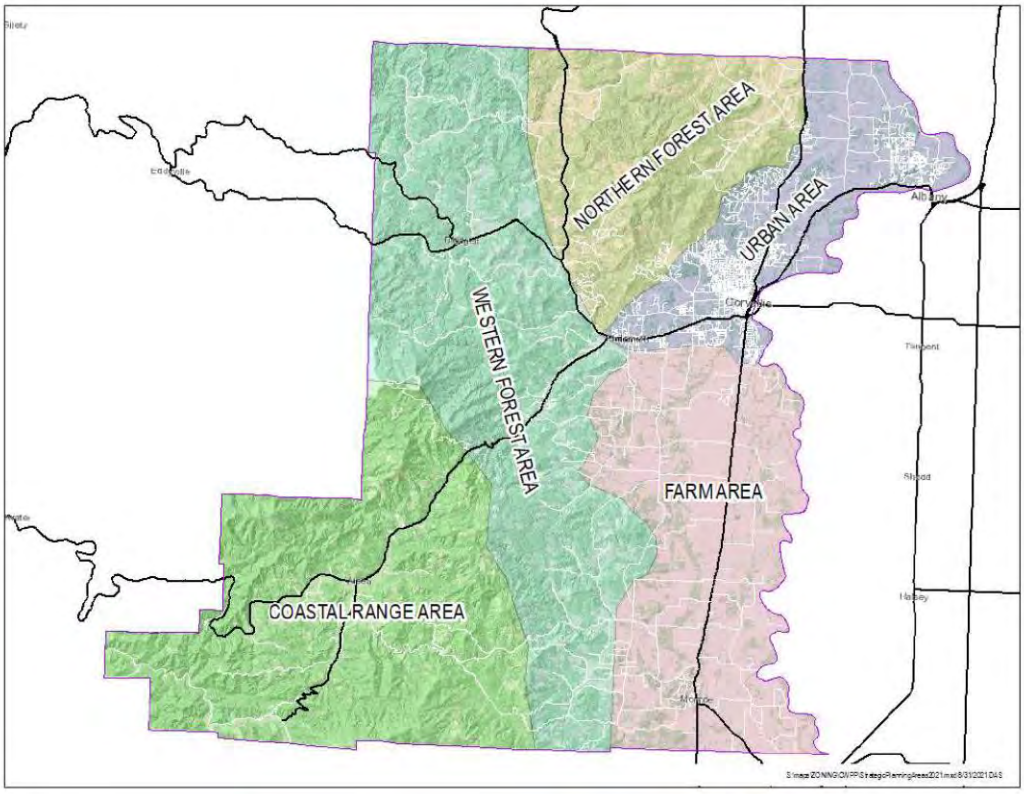
Vulnerability Assessment

The 2023-2028 Benton County Community Wildfire Protection Plan profiles five Strategic Planning Areas (SPA) based on fuel conditions that would require similar initial attach techniques. The plan also outlines the vulnerabilities of each SPA with respect to Ingress and Egress as well as infrastructure that could be exposed to damage by Wildfire.

Urban Area – SPA #1: Ingress and egress within the heavily populated urban areas is currently regulated through planning and building codes. Most of the roads in newer subdivisions have been designed to accommodate emergency vehicles with either loop roads or cul-de-sacs with wide turning radii and easily negotiable grades, which are better suited to all types of emergency response equipment.

Urban residents throughout most of SPA 1 have municipal water systems, which includes a network of public fire hydrants. New development is required by the International Fire Code to have hydrant placement in their development plan. Subdivisions and development outside municipal boundaries typically rely on community water systems or multiple-home well systems.

Figure 34. Benton County Community Wildfire Protection Plan Strategic Planning Areas



Source: Benton County Wildfire Protection Plan 2023-2028

Above ground, high voltage transmission lines cross the planning area in many directions in corridors cleared of most vegetation, which provides for a defensible space around the power line infrastructure and may provide a control point for fire suppression, if well maintained. Local public electrical utility lines are both above and below ground traveling through back yards and along roads and highways. Many of these lines are exposed to damage from falling trees and branches. Power and communications may be cut to some of these during a wildfire event.

Farm Area – SPA #2: Many access routes in this SPA are located in areas of risk due to the close proximity of continuous fuels along the roadway. Commercial forestlands generally have good logging roads enabling access for fire suppression equipment, however, many residences are accessed via unimproved, narrow roads and driveways accessible only by small emergency vehicles.

Residents living in Monroe have access to a municipal water system with public fire hydrants. Outside of Monroe, development typically relies on individual or multiple-home well systems. Creeks, ponds and developed drafting areas provide water sources for emergency fire suppression in the rural areas to a limited extent. Additional water resources distributed throughout the planning area are needed to provide water for fire suppression in a timely manner.

Local public electrical utility lines travel both above and below ground along roads and highways with some exposure to damage from wind and falling trees. Power and communications may be cut to some of these areas during a wildland fire event.

Northern Forest Area – SPA #3: Primary ingress and egress routes traveling north to south through SPA 3 include Highway 20 and 223 on the west and south side and Highway 99W on the east side. Primary access from the Soap Creek area to Highway 99W is via Soap Creek to Tampico Road and Coffin Butte Road. Many access routes are narrow and windy and driveways in this planning area are overgrown with vegetation, have bridges that are underrated for heavy equipment, are too narrow, or lack adequate turn out or turn around areas.

Residents within the communities of Kings Valley, Hoskins and Wren as well as the surrounding areas do not have access to municipal water systems; thus, no public fire hydrants are available. Development throughout this SPA typically relies on individual or multiple-home well systems. Ponds, rivers, creeks and developed drafting sites provide additional water sources for fire suppression in emergencies.

Above ground, high voltage transmission lines cross the planning area in corridors cleared of most vegetation, which provides for a defensible space around the power line infrastructure and may provide a control point for fire suppression, if well maintained. Local public electrical utility lines are both above and below ground traveling through back yards and along roads and highways. Many of these lines are exposed to damage from falling trees and branches. Power and communications may be cut to some of these areas during a wildfire event.

Western Forest Area – SPA#4: Primary access in the northern part of SPA 4 is via Highway 20 (Corvallis-Newport Highway). Secondary access funneling into Highway 20 includes the Summit/Blodgett Road, Hoskins/Summit Road and Marys River Road. There are also multitudes of paved and graveled secondary roads that crisscross the timbered areas. Many are single lane roads providing both ingress and egress, leading to homesites or logging units. Many access routes and driveways in this planning area are overgrown with vegetation, have bridges that are underrated for heavy equipment, are too narrow, or lack adequate turn out and turn around areas. In the event of a wildland fire, it is likely that one or more of the designated escape routes would become impassable.

Residents along the Alsea Highway near Philomath have limited access to a municipal water system. Those outside the city limits and in unincorporated areas typically rely on individual or multiple home well systems.

Local public electrical utility lines are both above and below ground traveling through back yards and along roads and highways. Many of these lines are exposed to damage from

falling trees and branches. Power and communications may be cut to some of these areas during a wildfire event.

Coast Range Area – SPA#5: Primary access is Highway 34 (Alsea Highway) and Lobster Valley/Alsea Road. Highway 34 is a heavily traveled route through the Coastal Range to the Oregon Coast. Many access routes and driveways in this planning area are overgrown with vegetation, have bridges that are underrated for heavy equipment, are too narrow, or lack adequate turn out and turn around areas. In the event of a wildland fire, it is likely that one or more of the designated escape routes would become impassable.

Residents within the town of Alsea have access to municipal water systems. In this area, public fire hydrants are available. Outside of Alsea, development typically relies on individual or multiple-home well systems. Ponds, rivers, creeks and developed drafting sites provide additional water sources for fire suppression in emergencies.

Local public utility lines traveling along roads and highways and are exposed to damage from falling trees. Power and phone service into forested areas are both above and below ground. Power and communications may be cut to some of these areas during a wildfire.

DOGAMI's Multi-Hazard Risk Assessment (MHRA) uses the Pacific Northwest Quantitative Wildfire Risk Assessment (PNRA): Methods and Results (Gilbertson-Day and others, 2018), a comprehensive database of spatial information related to wildfire hazard developed by the United States Forest Service (USFS) for the states of Oregon and Washington. For the MHRA DOGAMI used the burn probability dataset included in the PNRA database to measure the risk to communities in Benton County. Using guidance from Oregon Department of Forestry, the steward of this dataset in Oregon, DOGAMI's analyst 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 buildings layer and critical facilities were overlaid on each of the wildfire hazard zones to determine exposure.

The results of the analysis indicate the following wildfire exposure in Benton County.

Benton Countywide wildfire exposure (High or Moderate Risk):

- Number of buildings: 1,777
- Value of exposed buildings: $481,260,000
- Percentage of total county value exposed: 2.5%
- Critical facilities exposed: 2
- Potentially displaced population: 3,369

Locations identified locations within the study area that are comparatively at greater risk to wildfire hazard include the following:

- While the overall probability of wildfire hazard in Benton County is low, it is still a possibility, especially in the heavily forested rural areas. Nearby wildfire prone areas also pose a risk related to evacuation routes and hazardous smoke.
- Moderate to high risk of wildfire exists for the forested northern parts of the unincorporated county.

This analysis supports the overall assessment of vulnerability the Steering Committee concluded during the OEM Hazard Vulnerability Assessment exercise.

Windstorm

Significant Changes Since Previous Plan:

The Windstorm Hazard has been edited to reference new history since the 2016 update.

Characteristics

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. The most persistent high winds take place along the Oregon Coast and in the Columbia River Gorge. High winds in the Columbia Gorge are well documented. The Gorge is the most significant east-west gap in the Cascade Mountains between California and Canada. Wind conditions in central Oregon are not as dramatic as those along the coast or in the Gorge yet can cause dust storms or be associated with severe winter conditions such as blizzards. A majority of the destructive surface winds striking Oregon are from the southwest. Some winds blow from the east but most often do not carry the same destructive force as those from the Pacific Ocean.

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

Location and Extent

The most common type of wind pattern affecting Benton County is straight-line winds, which originate as a downdraft of rain-cooled air and reach the ground and spread out rapidly. Straight- line winds can produce gusts of up to 100 mph. For Benton County, the wind hazard levels are generally highest near the Willamette River and then fairly uniform across most of the rest of the county. In the mountainous areas, however, the level of wind hazard is strongly determined by local specific conditions of topography and vegetation cover. Mountainous terrain slows down wind movement, which is why Oregon's sheltered valley areas have the slowest wind speed in the state. However, in the foothills, the wind speeds may increase due to down-sloping winds from the mountains.

Although windstorms can affect the entirety of the county, they are especially dangerous in developed areas with significant tree stands and major infrastructure, especially above ground utility lines. A windstorm will frequently knock down trees and power lines, damage homes, businesses, public facilities, and create tons of storm related debris.

History

Windstorms occur yearly; more destructive storms occur once or twice per decade, most recently in December 2015. Of the following windstorms have occurred within, and/or near Benton County, seven windstorm events where wind speeds in excess of 70 mph were

recorded were added to this hazard history section since the previous plan *(shown in italics below*). All of these occurred in the Central Coast Range, however wind events with windspeeds ranging from 30 to 46 miles per hour also occurred in the Southern Willamette Valley section of Benton County[48]:

- **Jan. 1880**: Coast and Willamette Valley, In Portland, sustained south wind speeds of 60 mph were observed. Elsewhere, south winds were reported as high as 65 mph with gusts to 80 mph. Thousands of trees, many five to eight feet in diameter, were easily toppled in the high winds. Buildings throughout the Willamette Valley were destroyed. Hundreds more, including numerous large public buildings, were severely damaged.
- **Jan. 1921:** Coast and Willamette Valley, Hurricane-force winds were reported along the entire Oregon and Washington coasts. 113 mph was officially recorded at the north head of the mouth of the Columbia River on the Washington side. Very strong winds were also reported in the Willamette Valley. Widespread damage to buildings and standing timber.
- **Apr. 1931:** Western Oregon, unofficial wind speeds reported at 78 mph. Damage to fruit orchards and timber.
- **Nov. 10-11, 1951**: Statewide, widespread damage; transmission and utility lines; Wind speed 40-60 mph; Gusts 75-80 mph
- **Dec. 1951**: Statewide, wind speed 60 mph in Willamette Valley. 75 mph gusts. Damage to buildings and utility lines.
- **Jan. 20, 1953**: Corvallis, a "miniature tornado" (F0-F1) touched down in Corvallis destroying one building before moving into agricultural fields across the river. Rain and hail fell in sheets during this event, causing more damage estimated at $500,000.
- **Dec. 1955:** Statewide, Wind speeds 55-65 mph with 69 mph gusts. Considerable damage to buildings and utility lines
- **Nov. 1958**: Statewide, Wind speeds at 51 mph with 71 mph gusts. Every major highway blocked by fallen trees
- **Oct. 1962**: Statewide, *Columbus Day Storm*; Oregon's most destructive storm to date. 116 mph winds in Willamette Valley. Estimated 84 houses destroyed, with 5,000 severely damaged. Total damage estimated at $170 million
- **Oct. 1967**, Statewide, Significant widespread damage occurred to agriculture, timber, power and telephone utilities, and homes. Portland airport recorded a fastest mile of 70 mph. Wind speeds of 100 to 115 mph were unofficially recorded along the Oregon coast. There was one fatality and about 15 persons were seriously injured.
- **Mar. 1971**: Most of Oregon, Greatest damage in Willamette Valley. Homes and power lines destroyed by falling trees.

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[48] Taylor, George H., and Ray Hatton, 1999, The Oregon Weather Book; The Spatial Hazard Events and Losses Database for the United States, [Online Database]. Columbia, SC: University of South Carolina. U.S. Department of Commerce. National Climatic Data Center. Available at Climate Data Online (CDO) - The National Climatic Data Center's (NCDC) Climate Data Online (CDO) provides free access to NCDC's archive of historical weather and climate data in addition to station history information. | National Climatic Data Center (NCDC) (noaa.gov) National Weather Service Forecast Office.

- **Nov. 1981**: Most of Oregon, Highest winds since 1962. Wind speed 71 mph in Salem. Marinas, airports and bridges severely damaged.
- **Jan. 1990**: Statewide, Heavy rain with winds exceeding 75 mph. Significant damage, and one fatality.
- **Dec. 1996**: Statewide, Followed path of Columbus Day Storm. Wind speeds 62 mph in Willamette Valley. Damage to trees (saturated soil a factor) and homes. (FEMA-1107-DR-OR)
- **Nov. 1997**: Western Oregon, Wind speed 52 mph in Willamette Valley. Trees uprooted. Considerable damage to small airports.
- **Feb. 2002**: Western Oregon, Strongest storm to strike western Oregon in several years. Many downed power lines (trees); damage to buildings; water supply problems (lack of power). Estimated damage costs: $6.14 million. (FEMA-1405-DR-OR *declaration does not include Benton County*)
- **Dec. 15, 2005**: Willamette Valley, a decent windstorm moved up the Willamette Valley bringing strong winds to the central and southern valley. Affected electric utilities with significant damage to Consumer's Power Inc.
- **Feb. 2006**: Linn, Marion, Lane, Benton, Polk, Yamhill, windstorms with gusts up to 77 mph causes $227,000 in damages in Linn, Lane, Marion, Benton, Polk, and Yamhill Counties.
- **Dec. 1-3, 2007**: Oregon and Washington, a relentless storm pummeled the Oregon and Washington Coasts for 3 days bringing the strongest winds the area has seen since the Columbus Day storm.
- **Jun. 2009**: Willamette Valley, series of storms brought high winds, thunderstorms, rain, and hail.
- **Jan. 2012**: Severe winter storm, landslides, mudslides, flooding, including high winds (FEMA-4055-DR-OR)
- **Feb. 2014**: Coast and Willamette Valley, severe winter storm including high winds (FEMA-4169-DR-OR)
- **Dec. 2015**: Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides; Marys River reached flood levels, approximately 20 road closures in the county, downed trees and landslides. (FEMA-4258-DR-OR Benton County not included)
- ***March 1, 2016****: The BPA weather station at Marys Peak measured a peak gust of 78 mph, and the Rockhouse RAWS measured sustained winds of 42 mph with a gust up to 64 mph.*
- ***Jan. 17-18, 2017:*** *The Marys Peak weather station recorded a max sustained wind of 57 mph with gusts up to 84 mph. A Remote Automatic Weather Station (RAWS) in an adjacent zone measured wind gusts of 62 mph.*
- ***Feb. 8, 2017:*** *The weather station on Marys Peak recorded wind gusts up to 104 mph, while the Rockhouse RAWS station recorded wind gusts up to 96 mph.*
- ***Mar. 7, 2017:*** *A weather instrument on top of Marys Peak (elevation around 4,000 feet) recorded sustained winds up to 55 mph, with gusts up to 81 mph. High wind gusts also occurred in an adjacent zone.*
- ***Apr. 7, 2017****: A weather station on Marys Peak recorded wind gusts up to 93 mph. The Rockhouse RAWS recorded wind gusts up to 76 mph, and a spotter in Swisshome recorded a peak gust of 60 mph.*

- ***Apr. 7, 2018:*** *A strong low pressure system tracking northeast towards Vancouver Island generated strong winds along the Coast and in the Willamette Valley. The Eugene Airport ASOS recorded wind gusts of 45 to 49 mph.*
- ***Dec. 14, 2018****: A strong low-pressure system tracked northeast into British Columbia. The associated cold front brought with it strong southerly winds on the north and central Oregon coast. This system also brought windy conditions to the Willamette Valley, bringing down tree limbs and a few trees, which caused scattered power outages.*
- ***Jan. 13, 2021****: Tree blown down in Corvallis. Wind gust estimated from nearby observations from KCVO and E4613 on mesonet.*
- ***Dec. 11, 2021****: A strong Pacific front caused high winds along the coast and coast range, as well as strong winds through the Willamette Valley. Several reports of downed trees and branches as well as power outages for thousands of customers. A peak wind gust of 89 mph was measured at the Rockhouse RAWS.*
- ***Jan. 3, 2022:*** *The first of two strong Pacific fronts brought high winds to the coast as well as gusty winds to the Willamette Valley and interior lowlands of southwest Washington.*
- ***Feb. 27, 2022****: An atmospheric river event, starting late Sunday February 27th and continuing through Monday February 28th, brought heavy rain and strong winds to northwest Oregon and southwest Washington.*

Approximately 28 strong wind or high wind events have occurred in the Central Coast Range and the Southern Willamette Valley since the previous plan, not all of which have impacted locations in Benton County. For further details see the Storm Events Database provided by the National Oceanic and Atmospheric Administration. The eleven events added to the list above were notable due to the speed of gusting or sustained winds. None reached the level of damage caused by the December 2015 event that was declared a federal disaster in Linn, Lane, Lincoln and Polk counties among others in Oregon.

Probability Assessment

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

The table below 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 table shows that structures in Region 3, which includes the county, can expect to be exposed to 60 mph winds in a 25-year recurrence interval (4% annual probability).

Table 14. Probability of Severe Wind Events (Region 3)

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

Source: Oregon State Natural Hazard Mitigation Plan, 2009

Based on the participants' background and experience in Benton County the NHMP Steering Committee assessed the **probability of experiencing a Windstorm is high,** meaning one incident is likely within the next 10- to 35-year period. *This rating has not changed since the previous plan*. When Steering Committee members representing Benton County were asked to rank the relative probability of Windstorm from among the twelve hazards considered in this plan, they ranked it 10.3 out of 12 natural hazards, a high ranking.

Vulnerabilities

Many buildings, utilities, and transportation systems within Benton County are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It is also true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to 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 Benton County, trees are more likely to blow over during the wet winter season.

Using the OEM-FEMA Methodology (see page 2-99), the NHMP Steering Committee rated the county's residents as having a **moderate vulnerability to Windstorm hazards**, meaning that between 1-10% of the region's population or assets would be affected by a typical occurrence of the hazard. *This rating has not changed since the previous plan*. When Steering Committee members representing the county were asked to rank the relative vulnerability of Benton County residents to Windstorm, they estimated that Windstorm ranked 8.0 out of 12 hazards for vulnerability, a ranking in the middle third, or a moderate ranking.

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

Winter Storm (Snow/Ice/Extreme Cold)

Significant Change Since Previous Plan:

The Winter Strom hazard has been edited to reference new history since the 2016 Plan.

Characteristics

Winter storms affecting Benton County are generally characterized by a combination of heavy rains and high winds throughout the county, 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 section deals primarily with the snow and ice effects of winter storms.

The winter storms that affect Benton County 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.

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

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

Location and Extent

Ice storms occasionally occur in northern areas of Oregon, resulting from cold air flowing westward through the Columbia 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. Benton County is located within Zone 2: Willamette Valley. The climate in Zone 2 generally consists

of cool, wet winters and warm, dry summers.[49] These wet winters result in potentially destructive winter storms that produce heavy snow, ice, rain and freezing rain, and high winds.

Figure 35. Oregon Climate Divisions

Source: Oregon Climate Service,

The principal types of winter storms that occur include:

- **Snowstorms:** require three ingredients: cold air, moisture, and air disturbance. The result is snow, small ice crystals that fall from the sky. In Oregon, the further inland and north one moves, the more snowfall can be expected. Blizzards are included in this category.
- **Ice storms:** are a type of winter storm that forms when a layer of warm air is sandwiched by two layers of cold air. Frozen precipitation melts when it hits the warm layer and refreezes when hitting the cold layer below the inversion. Ice storms can include sleet (when the rain refreezes before hitting the ground) or freezing rain (when the rain freezes once hitting the ground).
- **Extreme Cold:** 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.

Unlike most other hazards, it is not simple to systematically map winter storm hazard zones. The entire county 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 county can face damage from winter storms and, for example, the hail or life threateningly cold temperatures that winter storms bring.

[49] Oregon Climate Service, "Climate of Benton County,"

History

Winter storms occur yearly; more destructive storms occur once or twice per decade, most recently in February 2021. The following winter storms have occurred within, and/or near Benton County, seven (7) winter storm events were added to this hazard history section since the previous plan (shown in *italics* below)[50]:

- **Dec. 1861**: Statewide, Snowfall varied between 1 and 3 feet. Did not leave Willamette Valley floor until late February
- **Dec. 1864**: Willamette Valley and Columbia Basin, Heavy snowfall. Albany (Linn County) received 16 inches in 1 day.
- **Dec. 1884**: Columbia River Basin and Willamette Valley, Most of the heavy snow fell over the Columbia River Basin from Portland to The Dalles and along the Cascades foothills in the Willamette valley. Albany received 19 inches.
- **Dec. 1892**: Northwest Oregon, Substantial snow fell across most of northern Oregon, with the greatest snowfall reported over northwestern Oregon. Corvallis received 18 inches of snow.
- **Jan. 1916**: Statewide, two snowstorms, each totaling 5 inches or more
- **Dec. 1919**: Benton County, Corvallis received 22 inches of snow and set an all-time low temperature record of 14 degrees F
- **Jan.- Feb. 1937**: Statewide, Heavy snow throughout the Willamette Valley. Corvallis received 18 inches of snow.
- **Jan. 1950**: Statewide, Heaviest snowfall since 1890. Many highway closures. Considerable property damage. Corvallis received 52 inches in snowfall for the month of January.
- **Jan. 1956**: Western Oregon, Packed snow became ice. Many automobile accidents throughout the region
- **Mar. 1960**: Statewide, Snowfall: 3-12 inches, depending on location. More than 100 snow related accidents in Marion County
- **Jan. 1969**: Statewide, for many areas, this was the most extreme storm on record. Snowfall over the state was much above normal, mostly in part due to a very cold January. Eugene had a total snow depth of 47 inches. Losses in livestock were heavy. Many communities were completely isolated for close to a week. At times, traffic on nearly every major highway west of the Cascades was halted. Property damage statewide totaled $3 million to $4 million.
- **Jan. 1980**: Statewide, a series of storms bringing snow, ice, wind, and freezing rain. Six fatalities.
- **Feb. 1985**: Statewide, Western valleys received between 2-4 inches of snow; Massive power failures (tree limbs broke power lines)
- **Dec. 1985**: Willamette Valley, Heavy snowfall throughout valley
- **Mar. 1988**: Statewide, Strong winds and heavy snow

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

- **Feb. 1989**: Statewide, Heavy snowfall and record low temperatures. Salem received 9 inches. Extensive power failures as well as considerable home and business damage resulting from frozen plumbing throughout the state.
- **Feb. 1990**: Statewide, The Willamette Valley was coated with 2 to 4 inches except the higher hills around Portland received up to 1 foot.
- **Dec. 1992**: Western Oregon, Heavy snow. Interstate Highway closed.
- **Feb. 1993**: Western Oregon, Record snowfall at Salem airport
- **Winter 1998**-9: Statewide, Series of storms. One of the snowiest winters in Oregon history
- **Dec. 2003 – Jan. 2004**: Statewide, Wet snow blanketed highways in the Willamette Valley, causing power lines and trees to topple. Oregon 34 east of Philomath was closed for 30 hours January 5 and 6 while crews removed trees. Critical services were disrupted, 10,000 customers without power for 3 to 4 days; one person died as a result of power outage. Presidential disaster declaration for 30 of Oregon's 36 counties *(FEMA-1510-DR-OR)*.
- **Dec. 2008**: Willamette Valley, a series of storms dropped feet of snow over portions of the Willamette Valley. The onset of cold air moved in around December 14 and lingered through Christmas morning (FEMA-1824-DR-OR Benton County not included)
- **Nov. 2011**: Benton County, heavy snow, accumulations between 5 and 7 inches
- **Jan. 2012**: Severe winter storm, landslides, mudslides, flooding, including high winds (FEMA-4055-DR-OR)
- **Mar.2012**: mixture of snow, rain, wind throughout much of the coast and Willamette Valley, snow accumulations up to 7-inches, trees down, roads closed.
- **Dec. 2013**: Willamette Valley, snow accumulations up to 9-inches
- **Feb. 2014**: coast and Willamette Valley, severe winter storm including high winds, snow accumulations up to 12-inches in Benton County (FEMA-4169-DR-OR)
- **Dec. 2015**: Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides; Marys River reached flood levels, approximately 20 road closures in the county, downed trees and landslides. (FEMA-4258-DR-OR Benton County not included)
- ***Dec. 14, 2016****: East winds ahead of an approaching low-pressure system brought temperatures down below freezing across the area ahead of the approaching precipitation. This led to a mix of freezing rain, sleet, and snow across the area.*
- ***Jan. 7-8, 2017****: General snowfall totals of 2-4 inches were reported, with the greatest total being 4.5 inches. Major ice accumulations occurred after the snow, with several locations reporting 0.50-1.00. The combination of snow and ice resulted in significant power outages and closures across the area.*
- ***Mar. 5-6, 2017****: The Benton County Emergency Manager reported snowfall rates above 650 feet of 2 inches per hour. By 6:22 pm, Highway 34 was impassable at the summit. A CoCoRaHS observer 7 miles NNW of Philomath recorded 5.9 inches of snow.*
- ***Feb. 24-25, 2019:*** *Generally, amounts of 8 to 16 inches of heavy, wet snow were reported generally around Brownsville southward, while lesser amounts of 1 to 4 inches were reported around Corvallis and Albany. The weight of the snow brought down hundreds, if not thousands of trees, resulting in numerous road closures and extended power outages. Heavy snow caused a roof to collapse at a high school*

gym. More than $13 million in damages were reported in the Southern Willamette Valley.

- ***Feb. 26-27, 2019**: There were several public reports of 4 to 8 inches of snow. This storm hampered recovery efforts from the February 24-25 snowstorm, extending power outages for many customers.*
- ***Feb. 12-13, 2021**: This was a major, widespread, multi-faceted winter storm that caused major problems across the Western Coast Range, and in the lowlands of the Southern Willamette Valley. Impacts were felt as far south as Albany. A trained spotter in Blodgett reported 0.75 of ice before it started melting the morning of the 13th.*

  This storm event was a declared disaster in Oregon Winter Storm 4599-DR-OR. Benton County was among the six affected counties.

- ***Dec. 24-25, 2021:** A prolonged winter weather event occurred across the Pacific Northwest during the Christmas holiday, resulting in significant travel issues across the coast range. Around 12 to 18 inches of snow fell in the Southern Willamette Valley during the weather event.*

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. Benton County experiences winter storms a couple times every year, to every other year.

Based on the participants' background and experience in Benton County the NHMP Steering Committee assessed the **probability of experiencing a Winter Storm is high,** meaning one incident is likely within the next 10- to 35-year period. *This rating has not changed since the previous plan*. When Steering Committee members representing Benton County were asked to rank the relative probability of Winter Storm from among the twelve hazards considered in this plan, they ranked it 10.1 out of 12 natural hazards, a high ranking.

Vulnerabilities

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 the county from winter storms should remain an ongoing process determined by community characteristics and physical vulnerabilities. Weather forecasting can give county emergency resource managers time to prepare for an impending storm by preparing emergency vehicles and warming shelters.

The most likely impact of snow and ice events on Benton County 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 as a result 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 the compounding effect of 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 of 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.

Using the OEM-FEMA Methodology (see page 2-99), the NHMP Steering Committee rated the county's residents as having a **moderate vulnerability to Winter Storm hazards**, meaning that between 1-10% of the region's population or assets would be affected by a typical occurrence of the hazard. *This rating has not changed since the previous plan*. When Steering Committee members representing Benton County were asked to rank the relative vulnerability of Benton County residents to Winter Storm, they ranked it 8.0 out of 12 natural hazards, in the middle third, or a moderate ranking.

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

Federal Disaster and Emergency Declarations

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

President Dwight D. Eisenhower approved the first federal disaster declaration in May 1953 following a tornado in Georgia. Since then, federally declared disasters have been approved within every state as a result of natural hazard related events. As of January 2024, in Benton County and Statewide, FEMA has made a total of 17 major disaster declarations, 27 fire

management assistance declarations, and two (2) emergency declarations in Oregon.[51] When governors ask for presidential declarations of major disaster or emergency, they stipulate which counties in their state they want included in the declaration. Table 15 summarizes the major disasters declared in Oregon that affected Benton County, since 1955. The table shows that there have been nine (9) major disaster declarations for the county (two since the previous plan). All of which were related to weather events resulting primarily in flooding, landslides, and wind related damage.

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. Benton County has only one recorded Emergency Declaration related to the 2005 Hurricane Katrina evacuation.

Fire Management Assistance may be provided after a State submits a request for assistance to the FEMA Regional Director at the time a "threat of major disaster" exists. There are no fire management assistance declarations on record for the county.

[51] FEMA, *OpenFEMA Dataset: Disaster Declaration Summaries -v2*, Disaster Declarations Summaries - v2 | FEMA.gov Accessed January 31, 2024.

Table 15. FEMA Major Disaster (DR), and Emergency (EM), and Fire Management Assistance (FMA) Declarations for Benton County

FEMA Declaration Number	Date	Designated Area	Declaration Title	Begin Date	End Date
DR-49-OR	1955-12-29	Statewide	FLOOD	1955-12-29	1955-12-29
DR-60-OR	1956-07-20	Statewide	STORM & FLOOD	1956-07-20	1956-07-20
DR-69-OR	1957-03-01	Statewide	FLOOD	1957-03-01	1957-03-01
DR-136-OR	1962-10-16	Statewide	SEVERE STORMS	1962-10-16	1962-10-16
DR-144-OR	1963-02-25	Statewide	FLOODS	1963-02-25	1963-02-25
DR-184-OR	1964-12-24	Benton (County)	HEAVY RAINS & FLOODING	1964-12-24	1964-12-24
FM-2008-OR	1973-08-17	Statewide	PERRY CANYON FIRE	1973-08-17	1973-08-17
FM-2010-OR	1973-08-18	Statewide	ROCKY CREEK FIRE	1973-08-18	1973-08-18
FM-2011-OR	1973-08-20	Statewide	ORINDALE DRAW FIRE	1973-08-20	1973-08-20
FM-2013-OR	1973-09-04	Statewide	DOE CREEK FIRE	1973-09-04	1973-09-04
FM-2014-OR	1973-09-07	Statewide	HILLSVIEW FIRE	1973-09-07	1973-09-07
DR-413-OR	1974-01-25	Benton (County)	SEVERE STORMS, SNOWMELT & FLOODING	1974-01-25	1974-01-25
FM-2030-OR	1978-08-11	Statewide	GRAVE CREEK FIRE	1978-08-11	1978-08-11
FM-2034-OR	1979-07-25	Statewide	BRIDGE CREEK FIRE	1979-07-25	1979-07-25
FM-2035-OR	1979-07-26	Statewide	SISTERS FIRE	1979-07-26	1979-07-26
FM-2036-OR	1979-08-03	Statewide	PINE GROVE FIRE	1979-08-03	1979-08-03
FM-2041-OR	1981-07-29	Statewide	ROUND LAKE FIRE	1981-07-29	1981-07-29
FM-2043-OR	1981-09-15	Statewide	PEAVINE PEAK	1981-09-15	1981-09-15
FM-2046-OR	1984-08-27	Statewide	LA PINE/WAMPUS BUTTE FIRE	1984-08-27	1984-08-27
FM-2060-OR	1987-07-16	Statewide	BLAND MOUNTAIN FIRE	1987-07-16	1987-07-16
FM-2064-OR	1987-09-02	Statewide	SYKES CREEK FIRE	1987-08-30	1987-08-30
FM-2063-OR	1987-09-02	Statewide	SAVAGE CREEK FIRE	1987-08-30	1987-08-30

FEMA Declaration Number	Date	Designated Area	Declaration Title	Begin Date	End Date
FM-2062-OR	1987-09-02	Statewide	FROZEN CREEK FIRE	1987-08-30	1987-08-30
FM-2066-OR	1987-10-10	Statewide	SHADY LANE FIRE	1987-10-09	1987-10-09
FM-2069-OR	1988-08-26	Statewide	WALKER MOUNTAIN FIRE	1988-08-23	1988-08-23
FM-2075-OR	1990-08-05	Statewide	AUBREY HALL FIRE	1990-08-04	1990-08-04
FM-2081-OR	1992-06-09	Statewide	SAGE FLATS FIRE	1992-06-09	1992-06-09
FM-2082-OR	1992-06-11	Statewide	ROUND LAKE FIRE	1992-06-11	1992-06-11
FM-2084-OR	1992-08-04	Statewide	LONE PINE FIRE	1992-08-01	1992-08-01
FM-2083-OR	1992-08-04	Statewide	EAST EVANS CREEK FIRE	1992-08-03	1992-08-03
FM-2112-OR	1994-08-24	Statewide	HULL MOUNTAIN FIRE	1994-08-24	1994-08-24
DR-1099-OR	1996-02-09	Benton (County)	HIGH WINDS, SEVERE STORMS AND FLOODING	1996-02-04	1996-02-21
DR-1107-OR	1996-03-19	Benton (County)	SEVERE STORMS AND HIGH WINDS	1996-12-10	1996-12-12
FM-2187-OR	1996-08-12	Statewide	WHEELER FIRE (WHEELER)	1996-08-12	1996-08-12
FM-2189-OR	1996-08-24	Statewide	SKELETON/EVANS WEST FIRE (DESCHUTES)	1996-08-24	1996-08-24
FM-2380-OR	2001-08-17	Statewide	OR MONUMENT COMPLEX 2380	2001-08-17	2001-08-22
DR-1510-OR	2004-02-19	Benton (County)	SEVERE WINTER STORMS	2003-12-26	2004-01-14
EM-3228-OR	2005-09-07	Benton (County)	HURRICANE KATRINA EVACUATION	2005-08-29	2005-10-01
DR-1632-OR	2006-03-20	Benton (County)	SEVERE STORMS, FLOODING, LANDSLIDES, AND MUDSLIDES	2005-12-18	2006-01-21
DR-1683-OR	2007-02-22	Benton (County)	SEVERE WINTER STORM AND FLOODING	2006-12-14	2006-12-15
DR-4055-OR	2012-03-02	Benton (County)	SEVERE WINTER STORM, FLOODING, LANDSLIDES, AND MUDSLIDES	2012-01-17	2012-01-21
DR-4169-OR	2014-04-04	Benton (County)	SEVERE WINTER STORM	2014-02-06	2014-02-10

FEMA Declaration Number	Date	Designated Area	Declaration Title	Begin Date	End Date
EM-3429-OR	2020-03-13Z	Benton (County)	COVID-19	2020-01-20	2023-05-11
DR-4562-OR	2020-09-15	Benton (County)	WILDFIRES AND STRAIGHT-LINE WINDS	2020-09-07	2020-11-03
DR-4599-OR	2021-05-04	Benton (County)	SEVERE WINTER STORM	2021-02-11	2021-02-15
DR-4499-OR	2020-03-28	Benton (County)	COVID-19 PANDEMIC	2020-01-20	2023-05-11

Source: Disaster Declarations Summaries - v2 | FEMA.gov

Phase 2: Community Assets and Vulnerabilities

Community vulnerabilities are an important component of the NHMP risk assessment. For more in-depth information regarding specific community vulnerabilities, reference Volume II, Hazard Annexes and Appendix C: Community Profile. Data sources for the following community vulnerability information can be found in Appendix C – *Community Profile*, unless otherwise noted below.

Population

The socio-demographic qualities of the community population such as language, race and ethnicity, age, income, and educational attainment are significant factors that can influence the community's ability to cope, adapt to and recover from natural disasters. Historically, 80 percent of the disaster burden falls on the public.[52] Of this number, a disproportionate burden is placed upon access and functional needs groups, particularly children, the elderly, the disabled, minorities, and low-income persons. Population vulnerabilities can be reduced or eliminated with proper outreach and community mitigation planning.

Population Vulnerabilities

- Based on US Census American Community Survey 5-year estimates from 2021, approximately 16.3% of Benton County's population is over the age of 64 and increase from 13% in 2014.
- The Benton County age dependency ratio[53] was calculated at 48.2 from the 2021 ACS 5-year estimates. The age dependency was 37.2 in 2014 and has increased beyond the predictions of the Office of Economic Analysis at the Department of Administrative services data cited in Table C-6 within Appendix C: Community Profile which projected an increase to 45.4 by the year 2035. This indicates that more of Benton County's population is dependent on the working aged population than in 2014.
- Approximately 11.4% of Benton County's population over age 65 lives alone. This is an increase from 9.4% in 2014. This portion of the population decreased in Corvallis since 2014 and was highest in the City of Albany based on the 2021 ACS 5-year estimates. See Table C-7 in Appendix C: Community Profile.
- Approximately 4.2% of the county's households are single parent households. This statistic decreased for the county and for all incorporated cities except Philomath since 2014. See Table C-8 in Appendix C: Community Profile.

- Median income in Benton County is lowest in Monroe and highest in Adair Village. See Table C-9 in Appendix C: Community Profile.

[52] Hazards Workshop Session Summary #16, *Disasters, Diversity, and Equity*, University of Colorado, Boulder (2000).

[53] Dependency Ratio: the ratio of population typically not in the work force (less than 15, greater than 64)

- Approximately 20.7% of the total Benton County population lived at or below the poverty line based on ACS 1-year estimates from 2022 with 15.4% of children living at or below the poverty line. In 2014, this statistic was 22.7%, with 14.4% of children. Corvallis has the highest percentage of total population in poverty (25.6%, 13,795 people). This data is cited in Table C-10 of Appendix C: Community Profile.
- While over 94% of the population over 25 has graduated high school or higher and more than 55% have a bachelor's degree or higher, the City of Albany and the City of Monroe have lower percentage of high school graduates or those with bachelor's degrees than the other cities in the county. See Table C-11 in Appendix C: Community Profile.
- Approximately 11% of the Benton County population is estimated to have a disability based on the US Census ACS 5-year estimates in 2021. Of that, 4,255 individuals over 65 (27.8%) are disabled. See Table C-12 in Appendix C: Community Profile.
- More than 51% of Benton County renters spent more than 35% of their income on housing in 2014. For the cities, those percentages was: 38% in Adair Village, 52% in Corvallis, 17% in Monroe, and 43% in Philomath.

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, Oregon's unemployment rate decreased further to 3.4% in 2023 from 7.5% in 2010 to less than 4% in 2016.
- The largest sectors of employment in Benton County in 2016 were State Government, mainly Educational Services (18%), Education and Health Services (16%), Trade, Transportation, and Utilities (12%), Professional and Business Services (11%), and Leisure and Hospitality (11%).
- The largest revenue sectors in 2016 in Benton County were Retail Trade ($731.0 million), Wholesale Trade ($452.5 million), and Manufacturing ($412.7 million).
- The Construction sector was expected in 2016 to have the most growth from 2012 to 2022 at 26%. Professional and Business Services (24%) and Education and Health Services (17%) were the next closest growth sectors.

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.[54] 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.

Built Environment, Critical Facilities, and Infrastructure

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

Housing Vulnerabilities

- Mobile home and other non-permanent residential structures accounted for *6.0*% of the housing in Benton County in 2014. In Monroe mobile homes accounted for 127.7%. These structures are particularly vulnerable to certain natural hazards, such as earthquake, windstorms, and heavy flooding events.
- Based on U.S. Census ACS 5-year estimates, slightly more than one-third of the residential housing in Benton County was built after the current seismic building standards of 1990.[55] Table C-19 in Appendix C: Community Profile shows these data.
- Approximately one-third of residential structures were constructed prior to the local implementation of the flood elevation requirements of the 1970's (county Flood Insurance Rate Maps –FIRMs- were not completed until the late 1970s and early 1980s). These data are also shown in Table C-19 in Appendix C.

Critical Facilities and Infrastructure Vulnerabilities

- Virtually all state and county roads and bridges in Benton County 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.

  Specifically noted during the hazard vulnerability assessment phase were:

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[54] Mayunga, J. "Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. Summer Academy for Social Vulnerability and Resilience Building," (2007) .

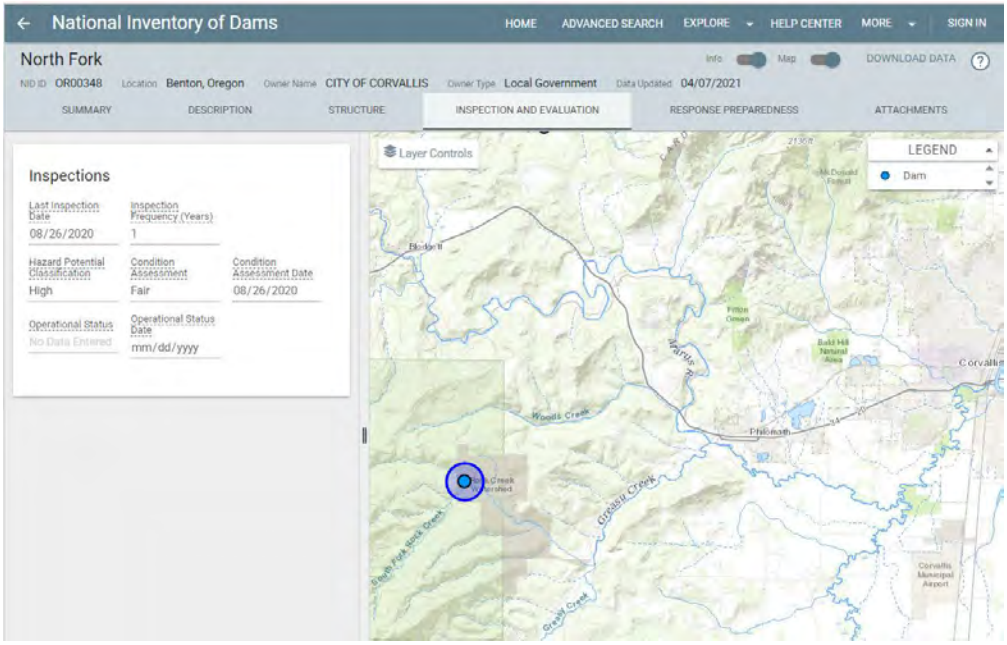
[55] Ibid.

- Lobster Valley Road was closed approximately 10 miles from Lobster due to the land slide. This route serves as an evacuation route for residents.
- Closures on State Route 34 have also impeded movement along that route, specifically noted were closures at milepost 20.
- Bridge on State Route 99W over the Long Tom River in the southwestern section of the City of Monroe.

- There is one general hospital in the county with 24/7 emergency room and inpatient services, located in Corvallis.
- All of Benton County's power is generated outside the region; there is no redundancy in power transmission and only limited redundancy in the power distribution network.
- There is one High Hazard Potential dam in Benton County, the North Fork Rock Creek Dam. The National Inventory of Dams identifies five other dams in Benton County, one of which, Thompson Dam, is identified as a Significant Hazard Potential dam. These rankings relate to the level of damage that could occur if the dam were to fail, not the likelihood of the dam failing. Additional information about the hazard of dam failure is available on pages 2-7 through 2-11.

The 2016 NHMP identified that there were 15 dams categorized as "low threat potential" in the county.

Figure 36. North Fork Dam Inspection and Evaluation, National Inventory of Dams



Source: National Inventory of Dams, consulted August 2023

National Flood Insurance Program (NFIP) Vulnerability

FEMA modernized the Benton County Flood Insurance Rate Maps (FIRMs) in June 2011; Corvallis was modernized in May 2012. The table below shows that as of April 2016, Benton County (including NFIP participating incorporated cities) has 763 National Flood Insurance Program (NFIP) policies in force. Of those, 569 are for properties that were developed

before the effective date of the initial FIRM. The last Community Assistance Visit (CAV) for Benton County was on March 2, 2016 (the most recent CAV for Corvallis was February 18, 2015). The county and Corvallis are members of the Community Rating System (CRS) and each have a Class 6 rating; the cities of Adair Village, Monroe, and Philomath are not CRS members (Adair Village is not an NFIP community because a flood insurance study has not been completed for the city and the entire city is within Zone D). The table shows that the majority of flood insurance policies are for residential structures, primarily single-family homes.

The county has a Certified Floodplain Manager who has served the county as floodplain manager for a substantial length of time. Each city maintains a floodplain manager role that is conducted by a range of city staff including public works staff and the city manager depending on the size of the city. The floodplain manager in each jurisdiction is responsible for applying substantial damage and substantial improvement regulations as required by their adopted FEMA compliant floodplain ordinances.

Table 16. Flood Insurance Detail for Benton County and Incorporated Cities in Benton County

Community[56]	FIRM Date	Initial FIRM Date	Total Policies	Pre-FIRM Policies	Single Family	2 to 4 Family	Other Res.	Non-Res.	Pre-FIRM Minus Rated Policies A Zone
Benton County	12/08/2016	8/5/1986	154	110	137	3	0	14	5
Corvallis	06/02/2011	1/3/1985	265	189	157	32	17	59	8
Monroe	06/02/2011	2/26/1975	2	1	2	0	0	0	0
Philomath	06/02/2011	6/15/1982	48	19	42	3	0	3	14

Community	Insurance in Force	Total Claims Since 1978	Pre-FIRM Claims Paid	Substantial Damage Claims	Total Paid Since 1978	Repetitive Loss Properties	Severe Repetitive Loss Properties	Class Rating	CAV Date
Benton County	$37,171,900	36	23	3	$260,961	13	0	7	02/25/2020
Corvallis	$84,867,600	24	21	0	$204,474	8	0	5	02/18/2015
Monroe	$549,000	0	0	0	$ 0	0	0	n/a	03/30/2020
Philomath	$11,988,500	4	4	0	$25,398	0	0	n/a	01/26/1998

There have been 36 paid claims in the county totaling $260,961. Of those 23 were Pre-FIRM claims and three were substantial damage claims. There are 13 Repetitive Loss (RL) Properties[57] located in Benton County and three (3) RL properties located in Corvallis. The floodplain managers estimate that all these RL properties are residential. There are no Severe Repetitive Loss Properties[58] located in the county.

[56] The City of Adair Village and the City of Albany are not included in this table. The City of Albany data is provided in the city's stand-alone NHMP. The City of Adair Village does not participate in the NFIP.

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

[58] A Severe Repetitive Loss (SRL) property is a single family property (consisting of 1 to 4 residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which 4 or more separate claims payments have been paid under flood insurance coverage, with the amount of each claim payment exceeding $5,000 and with cumulative amount of such claims payments exceeding $20,000; or for which at least 2 separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property.

Mitigation Successes

Between 2012 and 2021, six dwellings in unincorporated Benton County were replaced to reduce risk of flood damage or relocated to sites outside of the Special Flood Hazard Area, five of these since the last NHMP update in 2016.

- **2012-2014: A dwelling and three accessory structures located on Soap Creek Road west of Adair Village were relocated outside of the Special Flood Hazard Area.**
    - The dwelling and structures were built before the Benton County's Flood Insurance Rate Maps became effective.
    - A "severe repetitive loss" designation was assigned to property after the dwelling was substantially damaged by flooding in January 2012 and November 2012.
    - A variety of funding sources – including the property owner's flood insurance policy, an award from the Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program available as a result of FEMA's Disaster Declaration DR-4055-OR, and the Increased Cost of Compliance funds available through the property owner's flood insurance policy – assisted in the cost of relocating the structures to higher ground on the property and entirely outside of the Special Flood Hazard Area.
- **2016-2018: A second dwelling on Soap Creek Road west of Adair Village was relocated outside of the Special Flood Hazard Area.**
    - Although the dwelling had not been damaged by flooding, sandbags were required to keep water from entering during the 2012 flood events.
    - The property owners chose to relocate the dwelling to higher ground on the property that is entirely outside of the Special Flood Hazard Area.
- **2018-2019: A dwelling on Harris Road west of Philomath was mitigated as part of a renovation project.**
    - The dwelling was a historic structure built before the effective date of Benton County's Flood Insurance Rate Map and had a floor elevation that was below the Base Flood Elevation.
    - Although no flood damaged had occurred, the proposed renovations met the threshold for substantial improvement which required raising the dwelling's lowest floor to 1.5 feet above the Base Flood Elevation and adding flood-specific venting for the crawlspace.
    -
- **2018-2019: A dwelling on South 13th Street south of Philomath was mitigated through replacement and elevation.**
    - The original dwelling was built before Benton County's Flood Insurance Rate Map became effective.

- This dwelling was demolished and replaced with a dwelling that exceeds current Benton County floodplain requirements. The lowest floor of the replacement dwelling is 1.7 feet above the Base Flood Elevation and the crawlspace is properly flood-vented.

- **2020-2021: A dwelling on Fern Road south of Philomath was mitigated through replacement and elevation.**

    - The original dwelling was built before the effective date of Benton County's Flood Insurance Rate Map and had a floor elevation that was below the Base Flood Elevation.

    - The dwelling was listed as a repetitive loss property due to flood damage that occurred in December 2007 and January 2012.

    - The dwelling was demolished and replaced with a new dwelling that exceeds current Benton County floodplain requirements. The lowest floor of the replacement dwelling is 2.2 feet above the Base Flood Elevation and the crawlspace is properly flood-vented.

- **2022-2023: A dwelling on Powells Road south of Corvallis was mitigated as part of a renovation project.**

    - The dwelling was constructed before Benton County's Flood Insurance Rate Map became effective and had a floor elevation that was below the Base Flood Elevation.

    - Although no flood damage had occurred, the proposed renovations met the threshold for substantial improvement which required raising the dwelling's lowest floor and adding flood-specific venting for the crawlspace. The lowest floor of the dwelling is now 4 feet above the Base Flood Elevation.

Note: With the completion of the dwelling replacement project on Fern Road, unincorporated Benton County no longer has any repetitive loss or severe repetitive loss properties.

Phase 3: Evaluating the Impact of Natural Hazards: Vulnerability and Risk Assessment

The Benton County NHMP update Steering Committee utilized three methods for assessing vulnerability and risk to natural hazards. At a county level the project manager guided the Steering Committee through the OEM-FEMA Hazard Analysis Methodology.

The second methodology was a modification of this approach applied at the local level to provide differentiation among the regions of the county and for the several cities and the participating district within Benton County.

For multi-jurisdictional plans, the FEMA requires that the risk assessment assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

The four participating cities in Benton County (Adair Village, Corvallis, Monroe, and Philomath) and the Hoskins Kings Valley RFPD held small group meetings to discuss a jurisdiction specific hazard analysis based on the OEM-FEMA Methodology and adapted for use through an online survey tool. The OEM-FEMA Hazard Analysis Methodology is covered below. The detailed local level hazard risk assessments is located within the Risk Assessment sections of each city's addendum in Volume II of this Plan, however a summary of the probability and vulnerability factors of all of the city and district local level hazard risk assessments is included here below for context.

The third method was a Multi-Hazard Risk Analysis for Benton County conducted by the Department of Geology and Mineral Industry's Geohazard Analyst, Matt Williams in 2023. The analysis was conducted using HAZUS, a FEMA risk analysis model and also using depth grid evaluation of flood exposure based on FEMA's Special Flood Hazard data that provides base flood elevations. Because many of Benton County's SFHAs are only currently mapped as Approximate A zones, the entire county does not yet benefit from this detailed flood exposure analysis.

The analysis of the survey results (Appendix B and Appendix F) supports the conclusions that the Steering Committee drew. The public's elevated level of concern about the need to be prepared for evacuation and/or to shelter in place with appropriate supplies. A rich level of detail was gained from the open-ended questions and could serve to inform the public's needs.

OEM-FEMA Hazard Analysis Methodology

The OEM-FEMA Hazard Analysis methodology was first developed by FEMA circa 1983, and gradually refined in Oregon by the Oregon Department of Emergency Management 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.

History (Weight Factor = 2)

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

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

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

Probability (Weight Factor = 7)

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

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

Vulnerability (Weight Factor = 5)

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

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

Maximum Threat (Weight Factor =10)

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

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

A full description of the methodology is available from the Oregon Department of Emergency Management.

Among other things, this hazard analysis can:

- help establish priorities for planning, capability development, and hazard mitigation;
- serve as a tool in the identification of hazard mitigation measures;
- be one tool in conducting a hazard-based needs analysis;
- serve to educate the public and public officials about hazards and vulnerabilities; and
- help communities make objective judgments about acceptable risk.

Hazard Analysis Matrix

Working with the Steering Committee to complete the hazard analysis exercise involved estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time based on the experience and knowledge of the participants. Risk has two estimable components: (1) the magnitude of the harm that may result is estimated through the vulnerability assessment, and (2) the likelihood or probability of the harm occurring. The table below presents the consensus scores provided by the Steering Committee members to update the hazard analysis matrix for Benton County using the OEM-FEMA Hazard Analysis Methodology (OEM-FEMA Methodology).

The hazards are listed in rank order from high to low. The OEM-FEMA Hazard Analysis Methodology results in a Total Risk Score by adding the weighted factors for each individual natural hazard. It does not consider the impact of the occurrence of multiple natural hazard events at the same time. During this hazard analysis exercise with the group of Steering Committee participants for the 2022/2023 update Epidemic/Pandemic, Wildfire and Earthquake (Cascadia) ranked as the top natural hazard threats to the county. A natural break in the scores resulted in the ranking of Earthquake (Crustal), Windstorm, Drought, Flood and Winter Storms in a middle tier with Extreme Heat, Dam Failure, Landslide and Volcanic Event falling in the lowest tier.

Table 17. Benton County Hazard Analysis using the OEM-FEMA Methodology

Benton County 2022 Natural Hazard Vulnerability Assessment Rankings Based on the OEM-FEMA Hazard Analysis methodology combining factors of History, Probability, Vulnerability and Maximum Threat to help assess risk.													
HAZARD	HISTORY WF = 2			PROBABILITY WF = 7			VULNERABILITY WF = 5			MAX THREAT WF = 10			TOTAL SCORE
Epidemic/Pandemic	2 x	7	14	7 x	8	56	5 x	10	50	10 x	10	100	220
Wildfire	2 x	10	20	7 x	10	70	5 x	8	40	10 x	8	80	210
Earthquake(Cascadia)	2 x	2	4	7 x	7	49	5 x	10	50	10 x	10	100	203
Earthquake (Crustal)	2 x	3	6	7 x	6	42	5 x	7	35	10 x	10	100	183
Windstorm	2 x	10	20	7 x	10	70	5 x	6	30	10 x	6	60	180
Drought	2 x	3	6	7 x	8	56	5 x	7	35	10 x	8	80	177
Flood	2 x	10	20	7 x	10	70	5 x	5	25	10 x	6	60	175
Winter Storm	2 x	10	20	7 x	10	70	5 x	4	20	10 x	6	60	170
Extreme Heat	2 x	1	2	7 x	8	56	5 x	5	25	10 x	7	70	153
Dam Failure	2 x	1	2	7 x	2	14	5 x	8	40	10 x	9	90	146
Landslide	2 x	10	20	7 x	10	70	5 x	3	15	10 x	4	40	145
Volcano	2 x	1	2	7 x	5	35	5 x	4	20	10 x	5	50	107
Completed by the Benton County NHMP update Steering Committee during meetings held on July 21, 2022 and September 15, 2022													

Local Hazard Assessment

The second methodology that was used to prioritize and characterize the natural hazards addressed in this plan was a modification of this approach applied at the local level to provide differentiation among the regions of the county and for the several cities and the participating district within Benton County. Using an online survey tool each jurisdiction, district and the county representatives ranked the four factors for natural hazards addressed in the Plan for their particular location.

Following that exercise, the Benton County representatives discussed their assessment of the elements of risk to natural hazards in a small group meeting with the DLCD project manager to use their risk assessment to begin consideration of the Mitigation Strategy. During process of updating the NHMP, the variability throughout the county was identified, in particular the potential for impact from a Cascadia Subduction Zone on the community of Alsea as evacuation from the more affected coastal areas takes place.

To allow generalized categories, rankings of 1-4 are categorized as low, 5-8 are categorized as moderate, and 9-12 are categorized as high. The rankings are the result of seven representatives from Benton County providing their responses to the survey.

Figures 37 through 40 show the ranked responses for the representatives for Benton County alone for each of the four factors that comprise the OEM-FEMA methodology.

Figure 37. Ranking of History by Benton County

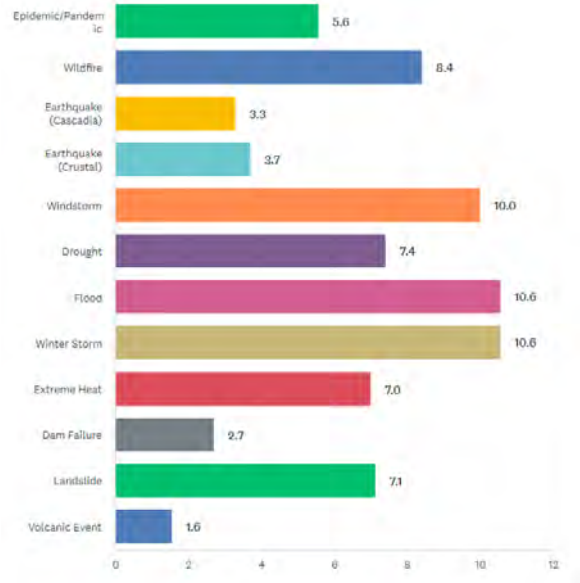


Figure 38. Ranking of Probability Benton County

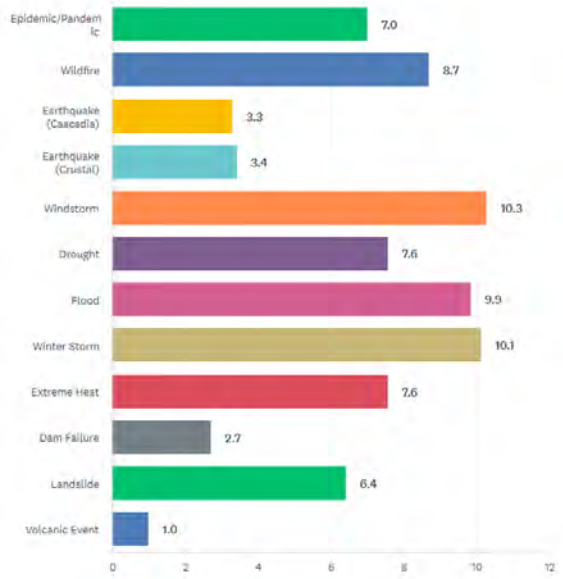


Figure 39. Vulnerability Ranking Benton County

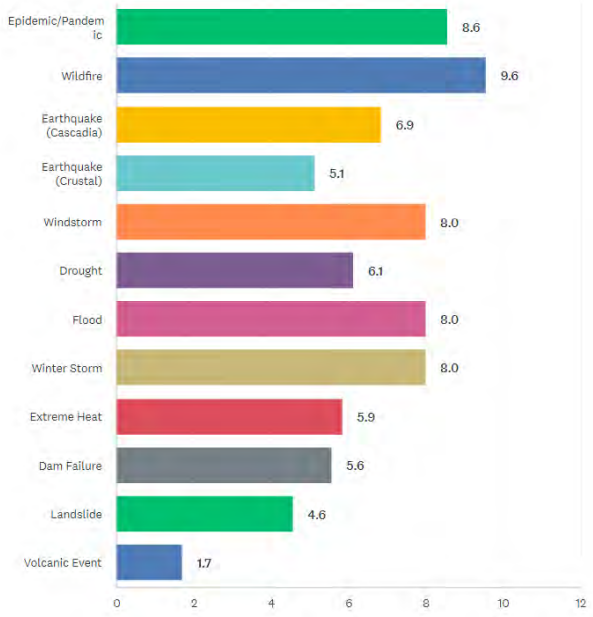
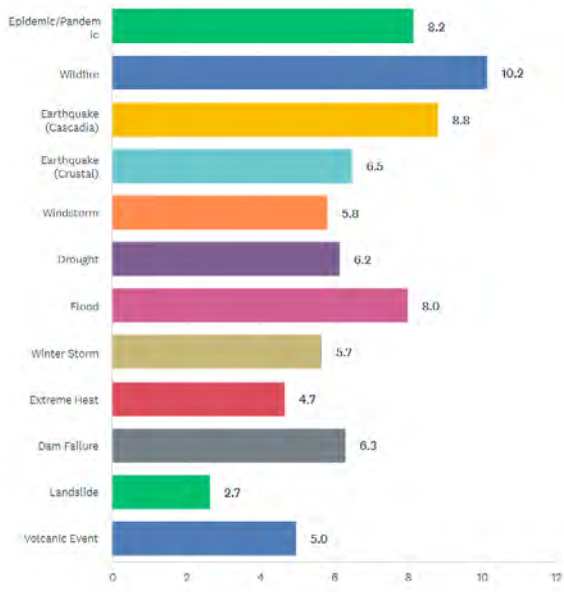


Figure 40. Maximum Threat ranking Benton County



Probability Summary

The table below presents only the probability rankings from the Local Hazard Assessment ranking exercise for each of the natural hazards addressed in the Benton County Plan. As shown in the table with color coding several hazards are rated consistently across the groups and representatives. The probability of Windstorms and Winter Storms is consistently ranked high, and the probability of Wildfires, Flooding and Extreme Heat events are also fairly consistently ranked High and Moderate. There is agreement as well about the low probability of Dam Failure and a Volcanic Event. The remainder are less consistently ranked.

Table 18. Natural Hazard Probability Ranking Summary

Probability Scores					
Hazard	**Benton County**	**Adair Village**	**Corvallis**	**Monroe**	**Philomath**
Dam Failure	Low	Low	Low	Low	Low
Drought	Moderate	Moderate	Moderate	High	Moderate
Earthquake (Cascadia)	Low	Moderate	Low	Low	Moderate
Earthquake (Crustal)	Low	Low	Low	Moderate	Moderate
Epidemic/Pandemic	Moderate	Moderate	Moderate	Moderate	Moderate
Extreme Heat	Moderate	High	Moderate	High	High
Flood	High	High	High	Moderate	High
Landslide	Moderate	Low	Moderate	Low	Moderate
Volcano	Low	Low	Low	Low	Low
Wildfire	High	Moderate	Moderate	Moderate	Moderate
Windstorm	High	High	High	High	High
Winter Storm	High	High	High	High	High

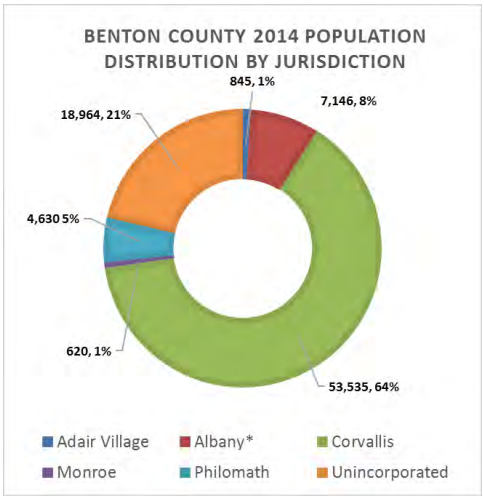
Source: Benton County and City NHMP Steering Committees members, 2022

Vulnerability Summary

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.

Vulnerability includes the percentage of population and property likely to be affected under an "average" occurrence of the hazard. Benton County evaluated the best available vulnerability data to develop the vulnerability scores presented below. For the purposes of this NHMP, the county and cities utilized the OEM-FEMA Hazard Analysis methodology vulnerability definitions to determine hazard vulnerability.

Figure 41. Benton County Population Distribution 2014



The table below presents only the vulnerability rankings from the Local Hazard Assessment ranking exercise for each of the natural hazards addressed in the Benton County Plan. As shown in the table with color coding several hazards are rated consistently across the groups and representatives. The Earthquake hazard, both crustal and CSZ are generally ranked as the hazard to which there is the most vulnerability. Overall, the ranking for Drought has increased somewhat having previously been ranked Low across the board. Both Volcanic Events and Landslide were ranked fairly consistently at a Low ranking for Vulnerability as was the case in the 2016 plan.

Table 19. Community Vulnerability Assessment Summary

Vulnerability Scores					
Hazard	**Benton County**	**Adair Village**	**Corvallis**	**Monroe**	**Philomath**
Dam Failure	Moderate	Low	Moderate	Moderate	Low
Drought	Moderate	Moderate	Low	Moderate	Moderate
Earthquake (Cascadia)	Moderate	High	High	High	High
Earthquake (Crustal)	Moderate	High	High	High	High
Epidemic/Pandemic	High	Low	Moderate	Low	Moderate
Extreme Heat	Moderate	Moderate	Low	Low	Moderate
Flood	Moderate	Moderate	High	Moderate	High
Landslide	Moderate	Low	Low	Low	Low
Volcano	Low	Low	Low	Low	Low
Wildfire	High	Moderate	High	Moderate	High
Windstorm	Moderate	High	High	High	Moderate
Winter Storm	Moderate	High	Moderate	High	Moderate

Source: Benton County and City NHMP Steering Committees 2022.

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

DOGAMI MHRA Risk Profiles

The DOGAMI Multi-Hazard Risk Assessment profiles for unincorporated Benton County and several small unincorporated communities are provided below along with the lists of critical facilities and their particular exposures to flood, channel migration (Alsea only), earthquakes, landslides and wildfire.

In general, the unincorporated portion of the county, like the cities, is most exposed to earthquake damage, based on this analysis. Exposure to the Cascadia Subduction Zone (CSZ) scenario resulted in more damage than the potential crustal earthquake scenario that was analyzed. Most of the critical facilities identified as being exposed to damage from a natural hazard are at risk from damage due to the CSC earthquake scenario.

Landslide hazard exposure is significant in several of the unincorporated communities. Summit, Blodgett and Alsea have exposures as high as 30% of the value of the structures located within them.

Flood endangers fewer structures in the county within rural and unincorporated communities, than the other hazards evaluated in this study. Wildfire exposure is greatest within the community of Summit at 34% of structures exposed to wildfire including the Blodgett-Summit RFPD Station. The community of Alsea was analyzed and 12 % of its structures are exposed to wildfire hazard, whereas 6.4% of structures in unincorporated Benton County are exposed to wildfire hazard.

Alsea is unique in that it is also exposed to the effects of the migrating channel of the Alsea River. This is a natural hazard that was not identified by the representatives for the county or for the community of Alsea but has been identified by this analysis. The GIS database that accompanies the DOGAMI publication allows the identification of these particular structures for future planning initiatives.

Table 20. Unincorporated Benton County (rural) hazard profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Unincorporated Benton County (rural)		20,766	16,331		15	3,934,253,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	828	4.0%	842	2	34,480,000	0.9%
Earthquake	CSZ Mw-9.0 Deterministic	806	3.9%	2,982	10	506,585,000	13%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	338	1.6%	1343	0	264,564,000	6.7%
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	2,516	12.1%	1,729	0	398,676,000	10%
Channel Migration	Channel Migration Zone	258	1.2%	254	0	53,663,000	1.4%
Wildfire	High and Moderate Risk	1,740	8.4%	1,172	0	250,624,000	6.4%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table 21. Unincorporated Benton County (rural) critical facilities

Critical Facilities and Lifelines by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed
Adair Village Sewage Treatment Plant	-	X	-	-	-	-
Alsea Food Bank	-	X	-	X	-	-
Alsea Gleaners	-	X	-	-	-	-
Camp Adair	-	X	-	-	-	-
Corvallis Locke Fire Station	-	-	-	-	-	-
Corvallis Municipal Airport	-	X	-	-	-	-
Corvallis Waldorf School	-	X	-	-	-	-
Crescent Valley High School	X	X	-	-	-	-
Former Fir Grove Primary School	-	X	-	-	-	-
Flying Tom Landing Strip	-	-	-	-	-	-
Hoskins - Kings Valley RFPD	-	-	-	-	-	-
Lobster Valley Church of Christ	-	-	-	X	-	-
Mountain View Elementary School	-	X	-	-	-	-
Muddy Creek Charter School	-	X	-	-	-	-
ODF Fire Station	-	X	-	-	-	-
Philomath Fire and Rescue Station 202	-	-	-	-	-	-
Philomath Fire and Rescue Station 203	-	-	-	-	-	-
Philomath Wastewater Treatment Plant	X	X	-	-	-	-
Rock Creek Water Treatment	-	-	-	-	-	-
The Alsea Fellowship Church	-	-	-	-	-	-
The Alsea Hope Grange	-	X	-	-	-	-
Wren substation	-	-	-	-	-	-

Table 22. Unincorporated community of Alpine Risk Profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Alpine		205	161		2	26,781,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	0	0	0	0.0%
Earthquake	CSZ Mw-9.0 Deterministic	22	10.7%	49	1	4,763,000	18%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	1	0.6%	3	0	522,000	1.9%
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	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	4	2.0%	2	0	291,000	1.1%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table 23. Unincorporated community of Alpine critical facilities

Critical Facilities and Lifelines by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Alpine School	-	X	-	-	-
Alpine Wastewater	-	-	-	-	-
Monroe Fire Department Station 1	-	X	-	-	-

Table 24. Unincorporated community of Alsea risk profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Alsea		216	137		2	30,315,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	17	7.7%	17	1	252,000	0.8%
Earthquake	CSZ Mw-9.0 Deterministic	45	21.0%	62	1	7,268,000	24%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	1	0.4%	4	0	531,000	1.8%
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	66	30.5%	32	0	5,466,000	18%
Channel Migration	Channel Migration Zone	79	37%	50	2	16,937	56%
Wildfire	High and Moderate Risk	28	13%	18	1	3,683,000	12%

[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 25. Unincorporated community of Alsea critical facilities

Critical Facilities and Lifelines by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Channel Migration Zone	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed	Exposed
Alsea Community School	X	X	-	-	X	X
Alsea Health Center	-	-	-	-	-	-
Alsea Public Library	-	-	-	X	-	-
Alsea substation	-	-	-	-	X	-
Alsea RFPD	-	-	-	-	X	-

Table 26. Unincorporated community of Bellfountain risk profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Bellfountain		82	59		1	14,814,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	0	0	0	0.0%
Earthquake	CSZ Mw-9.0 Deterministic	3	3.9%	17	1	4,184,000	28%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0%	2	0	674,000	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	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table 27. Unincorporated community of Bellfountain critical facilities

Critical Facilities and Lifelines by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Bellfountain Cornerstone Christian School	-	X	-	-	-
Monroe Fire Station 3	-	X	-	-	-

Table 28. Unincorporated community of Blodgett risk profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Blodgett		67	53		1	11,186,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	0	0	0	0.0%
Earthquake	CSZ Mw-9.0 Deterministic	8	12.0%	16	0	1,271,000	11%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0%	0	0	58,000	0.5%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	36	53.7%	22	0	3,195,000	29%
Wildfire	High and Moderate Risk	4	6.0%	3	0	1,282,000	11%

[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 29. Unincorporated community of Blodgett critical facilities

Critical Facilities and Lifelines by Community	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
	Exposed	>50% Prob.	>50% Prob.	Exposed	Exposed
Blodgett Elementary	-	-	-	X	-
Blodgett Summit FD Station 600	-	-	-	-	-

Table 30. Unincorporated community of Kings Valley risk profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Kings Valley		90	85		1	17,918,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	0	0	0	0.0%
Earthquake	CSZ Mw-9.0 Deterministic	12	13.3%	28	1	3,412,000	19%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	4	4.6%	18	0	2,214,000	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	0	0%	0	0	0	0%
Wildfire	High and Moderate Risk	0	0%	0	0	0	0%

[1]Facilities with multiple buildings were consolidated into one building complex.

[2]No damage is estimated for exposed structures with "First floor height" above the level of flooding (base flood elevation).

Table 31. Unincorporated community of Kings Valley critical facilities

	Flood 1% Annual Chance	CSZ 9.0 Earthquake Moderate to Complete Damage	Turner and Mill Creek 6.6 Moderate to Complete Damage	Landslide High and Very High Susceptibility	Wildfire High or Moderate Risk
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Kings Valley Charter School	-	X	-	-	-

Table 32. Unincorporated community of Summit risk profile

Community Overview							
Community Name		Population	Number of Buildings		Critical Facilities[1]	Total Building Value ($)	
Summit		113	96		1	20,026,000	
Hazus-MH Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Damaged Buildings	Damaged Critical Facilities	Loss Estimate ($)	Loss Ratio
Flood[2]	1% Annual Chance	0	0.0%	0	0	0	0.0%
Earthquake	CSZ Mw-9.0 Deterministic	12	10.7%	18	1	3,641,000	18%
Earthquake	Turner and Mill Creek Fault Mw-6.6 Deterministic	0	0%	1	0	177,000	0.9%
Exposure Analysis Summary							
Hazard	Scenario	Potentially Displaced Residents	% Potentially Displaced Residents	Exposed Buildings	Exposed Critical Facilities	Building Value ($)	Exposure Ratio
Landslide	High and Very High Susceptibility	40	35.7%	38	0	5,921,000	30%
Wildfire	High and Moderate Risk	26	23%	20	1	6,884,000	34%

[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 33. Unincorporated community of Summit critical facilities

	Flood 1% Annual Chance	**CSZ 9.0 Earthquake Moderate to Complete Damage**	**Turner and Mill Creek 6.6 Moderate to Complete Damage**	**Landslide High and Very High Susceptibility**	**Wildfire High or Moderate Risk**
Critical Facilities by Community	**Exposed**	**>50% Prob.**	**>50% Prob.**	**Exposed**	**Exposed**
Blodgett-Summit RFPD Station 2	-	X	-	-	-

SECTION 3: MITIGATION STRATEGY

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

Mitigation Plan Mission

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

The mission of the Benton County NHMP is:

> ***To make the community less vulnerable to the negative effects of natural hazards by coordinating efforts among government, public, and private sectors.***

The 2022/2023 NHMP Steering Committee reviewed the mission statement from the previous plan and determined that this goal still serves the purpose of the 2023 Benton County Multi-Jurisdictional Natural Hazard Mitigation Plan. The Steering Committee believes the concise nature of the mission statement continues to allow for a comprehensive approach to mitigation planning.

Mitigation Plan Goals

Mitigation plan goals are more specific statements of direction that Benton County citizens, and public and private partners can take while working to reduce the county'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.

Stakeholder participation during the 2015/2016 update process was a key aspect in developing the current plan goals. Meetings with the prior 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 Benton County.

The 2022/2023 Benton County MNHMP Steering Committee reviewed the 2016 plan goals and determined that these goals still align well with the State Natural Hazard Mitigation Plan (2020) goals and as well as current conditions in the county.

All the plan goals are important and are listed below in no particular 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.

Below is a list of the plan goals:

Goal 1: *Coordinate mitigation activities between government agencies.*

Goal 2: *Educate residents and businesses on the potential impacts of natural hazards as well as mitigation opportunities, in the community.*

Goal 3: *Identify and protect critical public facilities.*

Goal 4: *Increase connections between jurisdictions in an effort to collaborate on mitigation opportunities*.

Goal 5: *Increase resilience in areas of the county which currently have no emergency assistance.*

Action Item Development Process

Development of action items was a multi-step, iterative process that involved brainstorming, discussion, review, and revisions. Action items can be developed through a number of sources. During the 2022/2023 MNHMP update process, the jurisdictions used existing master planning documents as a source for mitigation strategy action development.

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

During the 2022/2023 MNHMP update process, the jurisdictions met in small groups to review all the mitigation strategy actions, both those previously classified as Priority and as Pool actions. The group began by considering the status of each action as a starting point for the discussion of mitigation strategy. The project manager and the small jurisdictional groups discussed how to make each action better reflect the mitigation strategy action relevant to each jurisdiction. This involved revising some action descriptions to make them SMART, or Specific, Measurable, Actionable, Realistic and Time sensitive. During these small group meetings, new mitigation strategy actions were identified. All actions were then reviewed by the Steering Committee and further revised as necessary before becoming a part of this document.

Mitigation Strategy Actions

Mitigation Strategy Action items identified through the planning process are an important part of the mitigation plan. These action items are descriptions of activities or projects that local jurisdictions can implement to reduce risk. Some of these actions are ongoing and are conducted as a part of existing staff duties usually funded through existing budgets. Some

of the actions are initiated, conducted, and concluded as discrete projects or activities that require grant or loan funding. Benton County participants discussed the relevance of each of the 2016 mitigation strategy actions and revised each of the stock action item descriptions to make them more relevant and applicable. Each action consists of a description and often additional notes to further detail the action item. A coordinating department or position and supporting agencies both internal and external are identified for each action as is the anticipated timeframe for implementation, potential funding sources and priorities when they are known. Further prioritization will take place during Plan Maintenance meetings.

The process of prioritization involved referencing other master planning documents (Water Master Plan, Stormwater Management Plans, Flood Management Plans and the Community Wildfire Protection Plan, for example) and Capital Improvement Plans to identify priority actions with support from the jurisdiction's administration, that address high risk hazards, and with available or identified resources. The process of prioritization also involves methodical approaches such as Benefit/Cost Analysis, Cost Effectiveness Analysis and the STAPL/E Approach, a quick evaluation of options to determine which warrant a more detailed analysis. All three of these methods are discussed in Appendix D.

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

Mitigation Strategy Action items for Benton County are included below (Volume I, Section 3). Mitigation Strategy Action items for the cities of Adair Village, Corvallis, Monroe, and Philomath as well as the Hoskins Kings Valley Rural Fire Protection District are located in each of the addenda in Volume II, *City Addenda.*

Action Item Tables

The Mitigation Strategy Action Item tables presents four groups of actions. Table 34 identifies actions that have been completed since 2016. Table 35 identifies actions that are conducted on an ongoing or periodic basis. Table 36 identifies projects or discreet actions that were identified during the action item development process, and Table 37 identifies mitigation strategy action items that were removed from the plan and the reasons for removing them.

Columns in these tables provide information as it was identified by the participants from each jurisdiction about the status of each action, the priority level (if known), the coordinating organization or department, an estimate of the timeline, potential funding sources, if needed, and notes to describe additional relevant details. During the plan maintenance or implementation phase of this project, the convener and the plan update or maintenance committee may use these tables to track progress and lay out next steps for implementing the mitigation strategy.

The involvement of the Oregon Department of Emergency Management staff is critical to success in obtaining FEMA funding for mitigation projects. They can be contacted through the State Hazard Mitigation Officer.

Table 34. Benton County Completed Action Items

2023 Action ID	Completed Action Item 2016-2023 – Benton County	2023 Status	2022-23 Update Notes
EQ #3	The county is building a new Courthouse that will be constructed with modern seismic codes. The historic Benton County Courthouse will remain in place but will not function as a vital public building.	Completed	The 2016 action was accomplished by another means. Seismic retrofitting is no longer required with a new building for the Benton County Courthouse.
WF #10	Obtain funding for a Type 6 Wildland Fire Engine for the Alsea Rural Fire District so that they can provide cross-jurisdiction help during wildfires.	Complete	The Alsea RFPD both identified and secured the funds to purchase this vehicle during the 2023 NHMP update process.

Table 35. Benton County Ongoing Action Items

2023 Action ID	2023 Ongoing Action Item – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2022-23 Update Notes
EQ #1	Use DOGAMI MHRA to analyze significant all-hazard vulnerabilities in critical public facilities. Develop an analysis of all-hazard resilience of infrastructure/lifeline systems (e.g. utilities and transportation systems, and emergency services and communication/ response facilities) as master planning for these systems takes place. Incorporate the analysis into master planning documents as they are updated.	Retained, revised	Benton County Public Works	Internal: Community Development External: Community Partners, ODOT, Private Utilities	Ongoing	County general funds, within existing capacity	

2023 Action ID	2023 Ongoing Action Item – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2022-23 Update Notes
FL #2	Actively participate in the National Insurance Program's Community Rating System and maintain at least a Class 7 rating.	Retained, revised	Benton County Floodplain Manager	Internal: Benton County Community Development Department External: Oregon NFIP Coordinator, FEMA, Vrisk - Insurance Services Office	Ongoing	County general fund, part of staff current capacity	• Maintain existing level of flood hazard communication and risk reduction activities through continued implementation of Benton County's floodplain program; • Identify opportunities to improve communication of flood risk to property owners and residents; • Identify opportunities to improve topic-specific flood risk communication to targeted audiences; and • Encourage community awareness of preparation for flood events, how to stay safe during a flood event, and what to do after a flood event.
FL #3	Improve county-maintained road network to provide continuous access during flood events where feasible.	Retained, revised	Benton County Public Works - Road Maintenance Division	Internal: Benton County GIS External: Marys River Watershed, DLCD, FEMA	Ongoing to Long-term as funds allow	Existing resources to analyze and FEMA BRIC grant for projects	• Identify locations that experience regular flooding, significant damage due to flooding, and frequent road closures during flood events. • Identify mitigation projects – such as upsizing culverts or storm drainage ditches – appropriate for each location. • Use the expected number of properties and structures that would be served by the identified mitigation projects to develop a prioritized list of projects to pursue.

2023 Action ID	2023 Ongoing Action Item – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2022-23 Update Notes
MH #2	Continue to deliver education programs aimed at mitigating the risks posed by hazards.	Retained and revised	Benton County Emergency Management	Internal: Benton County Community Development, Public Works External: Community organizations; cities and special districts; established community preparedness groups	Ongoing	Hazard Specific Grants that allow publication design and printing, potentially FEMA CTP grant	
MH #29 (Wildfire, Windstorm, Winter Storm, Volcanic Activity)	System hardening that is system-wide: -transitioning to metal & fiberglass power poles -add composite crossarms -transition to covered conductors -power system undergrounding -add protective fireproof wraps around wooden power poles	New Action	Consumer Power Inc.	Internal: Benton County Community Development, Benton County Emergency Management, Benton County Public Works External: Utility partners, Private landowners	Ongoing as funds come available	CPI Operating budget Oregon Department of Energy Oregon Department of Emergency Management	System hardening consists of building new infrastructure and retrofitting legacy infrastructure with more resilient materials. These materials stand up to damage better than traditional wooden system components. System hardening components include metal & fiberglass power poles, composite crossarms, covered conductors, system undergrounding, and protective fireproof wraps around wooden poles.

2023 Action ID	2023 Ongoing Action Item – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2022-23 Update Notes
MH #30 (Wildfire, Windstorm, Winter Storm, Volcanic Activity)	Enhance power system intelligence capabilities by running fiberoptic communication cables to new system components so that CPI can communicate with them without a linemen in the field.	New Action	Consumer Power Inc.	Internal: Benton County Community Development, Benton County Emergency Management, Benton County Public Works External: Utility partners, Private landowners	Ongoing as funds come available	CPI Operating budget Oregon Department of Energy Oregon Department of Emergency Management	System intelligence refers to efforts to enhance system control and automation through the CPI SCADA system. In the past, system components such as reclosers were exclusively manually operated by linemen in the field. CPI is investing in newer technologies that allow greater command and control of the system via our SCADA system. This means that CPI dispatchers can change system settings very quickly in response to threats. Compared to older technologies the difference in control allows system changes to be made in minutes instead of hours or days. This effort involves running fiberoptic communication cables to new system components so that CPI can communicate with them.
MH #31 (Wildfire, Windstorm, Winter Storm, Volcanic Activity)	Enhance knowledge of current weather conditions throughout CPI's Benton County regional system: -purchase Tempest Weatherflow systems -install Tempest Weatherflow systems	New Action	Consumer Power Inc.	Internal: Benton County Community Development, Benton County Emergency Management, Benton County Public Works External: Utility partners, Private landowners	Ongoing as funds come available	CPI Operating budget Oregon Department of Energy Oregon Department of Emergency Management	Environmental Intelligence refers to CPI efforts to characterize the current state of the lower levels of the atmosphere and analyze the potential effects to CPI system operations. Knowledge of current weather conditions is a key part of CPI's wildfire mitigation plan. Current weather conditions play a significant part in decisions about protective measures that CPI takes to prevent our system from starting fires. The rural nature of CPI's system means that existing publicly owned weather stations are often far from critical system components. The weather stations that do exist in CPI areas are often installed at an altitude that makes them unrepresentative of the conditions at the altitude of CPI's electrical system components. To remedy this CPI is going to buy and install Tempest Weatherflow systems over the next couple of years. CPI will purchase and deploy roughly 20-40 sensors throughout the service territory

2023 Action ID	2023 Ongoing Action Item – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2022-23 Update Notes
MH #6	Continue to incorporate the identified impacts of climate change on the natural hazards in Benton County in the Comprehensive Plan.	Retained and revised	Benton County Community Development	Internal: Benton County Sustainability Coordinator, Health Department, Corvallis Community Development and Public Works External: State Interagency Hazard Mitigation Team, DLCD, OSU, OCCRI	Ongoing	County general fund, within existing capacity	

Table 36. Benton County Progressing, Retained and New Actions sorted by Priority, if given and then by 2023 Timeline (short to long term), Alsea action items were not yet ranked by priority, are grouped at the end and are shaded blue grey

2023 Action ID	2023 Mitigation Project Action Items – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2023 Priority	2022-23 Update Notes
FL #1	Coordinate with FEMA and state agencies to maintain and update Benton County Flood Insurance Rate Maps as necessary. Prioritize the determination of Base Flood Elevations (BFE) for all approximate Zone A areas.	Progressing	Benton County Floodplain Manager	Internal: Benton County Community Development Department; Public Works Department; Public Information Officer; Emergency Services Division; Natural Areas, Parks & Events Department External: FEMA Risk MAP program, USACE, DOGAMI, DLCD, OEM, incorporated cities within Benton County, adjacent counties	Short to Long-term depending on project, see notes	FEMA Risk MAP, USACE funding	High	Luckiamute watershed flood map revisions are underway and expected to be finalized by the end of 2024. Lead agency: USACE Upper Willamette watershed flood map revisions are underway and expected to be completed by 2028-2030. Lead agency: FEMA RiskMAP team Additional coordination with USACE, DOGAMI, DLCD, OEM, adjacent counties, and Cities of Adair Village, Albany, Corvallis, Philomath, & Monroe. Additional coordination with USACE, DOGAMI, DLCD, OEM, and Cities of Adair Village, Albany, Corvallis, Philomath, & Monroe. Alsea watershed flood map revisions are included in the Upper Willamette watershed flood map revisions. Lead agency: FEMA RiskMAP Additional coordination with USACE

2023 Action ID	2023 Mitigation Project Action Items – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2023 Priority	2022-23 Update Notes
MH #27	Develop an All-Hazard Emergency Evacuation Route Priority Plan • Convene communities across Benton County to identify and prioritize Emergency Priority Route needs and gaps, • Incorporate community-identified needs and gaps into a comprehensive county-wide strategy that identifies priority evacuation routes, • Identify potential funding for priority routes, and • Adopt the Emergency Evacuation Route Priority Plan into the Benton County Comprehensive Plan and Development Code.	New Action	Benton County Community Development, Sheriff's Office Emergency Management and Public Works staff	Internal: External: Municipal governments, Community Hazard Stakeholders	Short term, 1-3 years	Purchase of software to map options possibly using ODOT Annual Grant Program, Hazard Mitigation Grant, or Fire Mitigation Grant	High	Benton County Planner recently did research for grants that would fund planning to support evacuation strategies. She identified an annual grant program within ODOT that would support planning for alternative evacuation routes. The representative for the community of Wren has identified a concern about areas where residences have a single access way. Developing alternative evacuation routes would reduce risks from wildfire for these people.
MH #28	Construct a new bridge on Hayden Road.	New Action, progressing	Benton County Public Works		Short term, 1-3 years	State of Oregon's Local Agency Bridge Program grant	High	The load limit on Hayden Bridge resulted in the design of a new bridge adjacent to the historic covered bridge there. The design of the bridge is in process and construction funds have been identified. Construction is slated for 2025-26

2023 Action ID	2023 Mitigation Project Action Items – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2023 Priority	2022-23 Update Notes
FL #7	Develop targeted flood risk mitigation projects for structures at risk of flooding in Benton County.	Retained, revised	Benton County Floodplain Manager	Internal: Benton County Community Development Department, Public Information Officer, Public Works Department, Emergency Services Division External: DLCD, DOGAMI, FEMA, USACE	Mid- to Long-term (3-5 years) or more	FEMA Flood Mitigation Assistance grant, DLCD Technical Assistance, USACE, OEM, local capital improvements project funding	High	This bulleted list below provides a set of discrete projects that could be funded a bit at a time if there are smaller chunks of funding and also provides a total picture in case a large amount of funding can be secured. • Identify all structures (by type) with floor elevations below the Base Flood Elevation. • Evaluate identified structure locations to determine if there are distinct clusters of structures or if they are spread out. • Evaluate identified structure types to determine how many are dwellings, commercial structures, schools, centers for community gathering, government buildings, accessory structures, etc. • Develop a prioritized list of scalable mitigation projects based on location, structure types, and type of mitigation needed. • Provide outreach to owners of identified structures informing them of expected flood risks and potential mitigation methods. • Identify and pursue funding opportunities to implement identified mitigation projects.
DR #1	Develop a drought impact assessment for Benton County	Retained	Benton County Community Development	Internal: Benton County Public Works, Emergency Management, and Health departments External: OSU Extension, Benton County Soil and Water Conservation District, Marys River Watershed Council, Oregon Climate Change	Medium term, 3-5 years	Climate Adaptation Grants potentially through Oregon Health Authority (OHA)	High	

2023 Action ID	2023 Mitigation Project Action Items – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2023 Priority	2022-23 Update Notes
				Research Institute, Oregon Water Resource Dept., Silver Jackets, OHA				
MH #26	Invest in the communications infrastructure that supports the Benton County first responders, road crews, etc. in accordance with the Radio Infrastructure Assessment and Improvement Plan. Align these projects with the Interoperable Communications Plan within the Region.	New Action	Benton County Sheriff's Office, Corvallis Regional Communicatio n District	Benton County Fire Defense Board, Benton County Rural Fire Protection Districts	Long term, >5 years	Assistance to Firefighters (AFG) BRIC Grant	High	
MH #1	Determine whether Benton County can develop franchise utility agreements with the "dry utilities". If that is possible, then code changes to require undergrounding utilities could be pursued.	Retained and revised	Benton County Public Works	Internal: Benton County Community Development, GIS External: Public Utility Commission, Consumers Power, Inc., Pacific Power	Long term (>5 years)	FEMA BRIC Grant or other Hazard Mitigation Grant, Fire Mitigation Grant	High	There are no regulations requiring undergrounding utilities at the county level; City agreements are franchised, and the city can then regulate the placement of those dry lines. If Benton County can develop franchise utility agreements with the "dry utilities", then code changes to require undergrounding utilities could be pursued.
MH #4	Develop detailed inventories of at-risk public buildings and infrastructure and prioritize mitigation actions, especially for critical facilities.	Progressing	Benton County Community Development	Internal: Benton County Public Works, Benton County Sheriff's Office/Emergency Management, Benton County Health/Environmental Health, Natural Areas Parks & Events External: Regional Fire	Short to Medium term, 2-5 years	Hazard Mitigation Grant Homeland Security Grant	Medium	This action is partially completed because the DOGAMI database that accompanies the Multi-hazard Risk Report prepared for this NHMP update. It identifies at risk public buildings, but infrastructure was not part of that assessment. Further inventory, risk assessment and prioritization may be work that the NHMP Steering Committee can do during Plan Maintenance meetings during the life of the plan pending participation by the relevant partners. Potentially

2023 Action ID	2023 Mitigation Project Action Items – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2023 Priority	2022-23 Update Notes
				Districts, Benton County cities, DOGAMI, FEMA				a RARE student or an intern could make this work more efficient.
WF #1	Implement actions identified in the Community Wildfire Protection Plan.	Retain	Benton County Community Development	Internal: Emergency Management staff External: Oregon Department of Forestry	Short to Long-term depending on the action	OSFM, FEMA BRIC grant		The actions referred to are detailed in the Community Wildfire Protection Plan
LS #1	Utilize the updated regional landslide risk maps (DOGAMI O-16-02 and O-21-14) 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.	Retain	Benton County Community Development	External: DOGAMI, DLCD	Medium term, 3-5 years	Hazard Mitigation Grant	Medium to High, as determined by the BOCC	This action should be incorporated into a voluntary periodic review depending on the issues the Board of County Commissioners determine should be incorporated in such a work program.
MH #3	Integrate the Mitigation Plan findings into planning and regulatory documents and programs including Comprehensive Plans.	Retained and progressing	Benton County Community Development	Various depending on the issues, scope and scale addressed during Comprehensive Plan review	Medium term, 3-5 years	County general fund, within existing capacity	Medium to High, as determined by the BOCC	Benton County Planning Commission and Board of Commissioners have identified several long range planning needs, including the need to plan for wildfire and water resilience. Any County efforts to address natural and other hazards in the comprehensive plan should consider the NHMP and should specifically incorporate portions of the NHMP as appropriate into the comprehensive plan, development code and other relevant County policies.

2023 Action ID	2023 Mitigation Project Action Items – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2023 Priority	2022-23 Update Notes
FL #5	Support the City of Philomath in mitigating the flooding of South 13th Street area as infrastructure improvements are made	Retain, revised	Benton County Public Works - Road Maintenance Division	External: City of Philomath	Medium to Long term, 3-5 years or more	County Road Fund, potential CAMPO funding	Medium	
MH #5	Develop appropriate and necessary community recovery plans starting with the highest priority hazards. Continue to integrate hazard, vulnerability and risk mitigation plan findings into enhanced emergency operations planning.	Retained and revised	Benton County Emergency Management	Internal: Benton County Community Development, Health Department, Public Works External: NAPE, Utilities, other partners as necessary	Medium term, 3-5 years	Hazard Mitigation Grant Homeland Security Grant Fire Mitigation Grant	Medium	Potentially a RARE student or an intern could make this work more efficient.
WF #5	Improve remote draft site at Daisy Drive in Marys River Estates by replacing the fixed water pump from the late 1960's or early 1970's with two portable pumps that will provide more reliability and will be easier to maintain.	Progressing	Philomath Fire & Rescue Deputy Fire Chief	Internal: Benton County Planning, Public Works External: Marys River Estate residents	Short-term (1-2 yrs)	Philomath Fire and Rescue District funds	Low-Medium	Prior improvements to this draft site include better road surfaces and concrete flooring added to the pump housing. The portable pumps are being procured and are scheduled to be in service by March 2024. The Marys River Estates Road District and Property Owners Association will maintain access to the existing pump house.
MH #12	Rebuild the railroad crossing on SW 53rd Street south of SW Reservoir Avenue.	Retained	Benton County Public Works	Internal: Community Development External: Willamette & Pacific Railroad, Union Pacific Railroad	Long term, >5 years	The county has applied for federal funding for final design and construction but has not yet been successful in securing funding for this project.	Low	

2023 Action ID	2023 Mitigation Project Action Items – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2023 Priority	2022-23 Update Notes
WF #4	Conduct oureach effort to inform the public and other property owners such as timber companies about ways to reduce hazard risks to electricity or other utility infrastructure during the completion of routine projects.	New Action	Benton County Community Development and Public Works Departments	Internal: Emergency Management External: Utility providers	Medium term, 3-5 years	County General Fund	Low	This would include information to timber companies that removing all the trees adjacent to power lines may limit risk to them from high winds or landslides. This would also include information to power companies about the Benton County PW practice of encouraging making temporary utility bypasses to become permanent during bridge and culvert replacements.
WF #7	Consider development of a plan to upgrade Alsea's water system. This involves identifying funding sources and detailing the needed upgrades.	New Action	Benton County Public Works	Internal: Benton County Community Development, Alsea Community Effort (ACE) External: OEM, OSFM	Long term, >10 years	Community Development Block Grant, USDA Rural Development Assistance - Utilities grant	Low	No assessment has been done to establish what upgrades might be needed, and if a cost/benefit analysis will support proposed upgrades. Examples of possible upgrades could include replacement of existing 3" pipes with 6" pipes, constructing additional water storage facilities, and installing additional fire hydrants to ensure adequate capacity for fire fighting within the community.
EQ #6	Seismically retrofit the Alsea Rural Fire Protection District fire station.	New Action	Alsea Rural Fire Protection District	Alsea Community Effort (ACE), Emergency Management	Long term (>5 years)	Business Oregon's Seismic Rehabilitiation Grant Program, BRIC Grant		Note: The DOGAMI report does not identify the Alsea RFPD station as being vulnerable to an earthquake.
LS #4	Obtain a geotechnical assessment for the hillside north of the Alsea Clinic to determine the vulnerability of the clinic to landslides, and if necessary, what actions to be taken to safegaurd the clinic.	New Action	Benton County Community Development	External: Alsea Community Effort (ACE), DOGAMI	Medium term, 3-5 years			

2023 Action ID	2023 Mitigation Project Action Items – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2023 Priority	2022-23 Update Notes
MH #11	Assess vulnerability of routes feeding into South Fork Rd to improve evacuation capacity on that road.	Retained and revised	Benton County Public Works	Internal: Benton County Emergency Management, Benton County Community Development, Alsea Emergency Preparedness Council, Alsea School District, Alsea Rural Clinic, Alsea Library, Alsea Rural Fire Protection District External: ODOT, OEM	Medium to Long term (>3 years)	ODOT Annual Grant Program Hazard Mitigation Grant Fire Mitigation Grant		
MH #24	Seismically retrofit the Alsea School.	New Action	Alsea School District	Alsea Community Effort (ACE)	Long term (>5 years)	Business Oregon's Seismic Rehabilitiation Grant Program BRIC Grant		The school is likely to be the main community meeting place and shelter in an emergency event. **Potential funding source:** Business Oregon's Seismic Rehabilitiation Grant Program.
MH #25	Provide facility upgrades to Alsea School, such as an industrial kitchen, so that the school may serve as a natural hazard shelter for the community.	New Action	Alsea School District	Alsea Community Effort (ACE)	Long term (>5 years)			The school is likely to be the main community meeting place and shelter in an emergency event
WF #6	Install a water storage tank in Alsea that supports the Alsea Rural Fire Protection District.	New Action	Benton County Public Works, Alsea Rural Fire Protection District					

2023 Action ID	2023 Mitigation Project Action Items – Benton County	2023 Status	2023 Coordinating Organization or Individual	2023 Partner Organizations	2023 Timeline	2023 Potential Funding Sources	2023 Priority	2022-23 Update Notes
WF #8	Install a fire radio station at the Alsea Rural Fire Protection District Fire Station to improve the communication system of the district.	New Action	Alsea Rural Fire Protection District	Benton County Fire Defense Board, Corvallis Regional Communication District	Medium term, 3-5 years			A Fire Radio Station can monitor frequencies from many agencies including ODF, Benton County, and more locally the Alsea Ham station.
WF #9	Install a sprinkler system in the Alsea Fire Hall.	New Action	Alsea Rural Fire Protection District	Alsea Community Effort (ACE)	Long term, >5 years			

Table 37. Action Items removed from the 2023 Benton County MNHMP

2016 Action ID	2016 Action Item	2023 Status	2022-23 Update Notes
FL #4	Ensure the locations of Repetitive Loss Properties have been accurately registered with FEMA and work with affected RL, and other flood prone, property owners to remove, relocate, or elevate non-conforming, pre-FIRM structures in flood hazard areas.	Remove	Remediation of Repetitive Loss properties will be addressed through other mitigation strategies in this plan.
EQ #2	Explore the possibility of developing a home seismic upgrade/retrofit (structural and non-structural) program. Consider an education/marketing program.	Remove	This action was determined not be be within the capacity of the county. Oregon Department of Emergency Management may have access to more expertise and resources for such a program.

SECTION 4:
PLAN IMPLEMENTATION AND MAINTENANCE

The Plan Implementation and Maintenance section details the formal process that will chart how that the NHMP can remain an active and relevant document. The plan implementation and maintenance process includes a schedule for monitoring and evaluating the plan semi-annually, and producing an updated plan every five years. Finally, this section describes how the county will integrate public participation throughout the plan maintenance and implementation process.

Implementing the Plan

The success of the Benton County MNHMP depends on how well the outlined action items are implemented. To ensure that the activities identified are implemented, the following steps will be taken: 1) the plan will be formally adopted, 2) a coordinating body will be assigned, 3) a convener shall be designated, 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 Benton County MNHMP was developed and will be implemented through a collaborative process. After the plan was locally reviewed and deemed complete, the DLCD project manager submitted it to the Mitigation Planner at the Oregon Department of Emergency Management (ODEM). ODEM submitted 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 acceptance by FEMA, the county adopted the plan by resolution. The DLCD project manager will forward the resolution of adoption to the Mitigation Planner at ODEM who will subsequently send it to FEMA Region X. When FEMA Region X receives the resolution of adoption, they will issue the approval letter indicating the dates through which this plan is effective. The DLCD project manager will complete final revisions on this plan to include these official documents in Appendix I.

The FEMA approval letter will indicate that the county has regained eligibility for the Building Resilient Infrastructure and Communities (BRIC) program, the Hazard Mitigation Grant (HMGP) program funds, and Flood Mitigation Assistance (FMA) program funds. Following the adoption by the county, the participating jurisdictions should also convene local decision makers to adopt the Benton County Multi-jurisdictional NHMP by resolution.

Convener

The Benton County Emergency Services Planner will take responsibility for plan implementation and will facilitate the Natural Hazard Mitigation Plan Steering Committee meetings and will assign tasks such as updating and presenting the plan to the rest of the members of the Coordinating Body (see City Addenda for city conveners). Plan implementation and evaluation will be a shared responsibility among all of the Natural

Hazard Mitigation Plan Steering Committee members. The Convener's responsibilities include:

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

Steering Committee

The Benton County Convener will coordinate the MNHMP Steering Committee. The Convener and the NHMP Steering Committee will update and implement the MNHMP together. The MNHMP Steering Committee responsibilities include:

- Attend future plan maintenance and plan update meetings (or designate a representative to serve in that role);
- Serve as the local evaluation committee for funding programs such as the Building Resilient Infrastructure and Communities program, the Hazard Mitigation Grant Program funds, 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/or standing subcommittees as needed; and
- Coordinate public involvement activities.

Steering Committee Members and Interested Parties

The following jurisdictions, agencies, and/ or organizations were represented and served on the MNHMP Steering Committee during the development of the Benton County NHMP (for a list of individuals see Appendix B - *Acknowledgements*):

- Benton County
- City of Adair Village
- City of Corvallis
- City of Monroe
- City of Philomath
- Hoskins Kings Valley Rural Fire Protection District

The Steering Committee drew on technical reports and in person presentations by the following state agency and research institute.

- Oregon Department of Geology and Mineral Industries
- Oregon Climate Change Research Institute, OSU

The following jurisdictions, agencies and/or organizations joined the MNHMP Steering Committee as Interested Parties to the MNHMP Steering Committee.

- Oregon State University (OSU)
- Linn County
- City of Albany
- Alsea representative, Alsea Community Effort (ACE)
- Wren Disaster Preparedness Network
- Adair Rural Fire District
- Philomath Fire and Rescue
- Linn Benton Community College

To make the coordination and review of the Benton County MNHMP as broad and useful as possible, the Steering Committee will engage additional stakeholders and other relevant hazard mitigation organizations and agencies to implement the identified action items. Specific organizations have been identified as either internal or external partners on the individual action item forms found in Section 3: Mitigation Strategy and in Appendix A.

Implementation through Existing Programs

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

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

Examples of plans, and codes in Benton County that may be used to implement mitigation activities include:

- County Budget
- Capital Improvement Plan
- 2023-2028 Community Wildfire Protection Plan
- 2007 Benton County Comprehensive Plan
- County Development Code
- County Zoning Map
- County Emergency Operations Plan

- Continuity of Operations Plan
- Alsea Emergency Response Plan, updated 2021

For additional examples of plans, programs or agencies that may be used to implement mitigation activities refer to list of plans in Appendix C, *Community Profile*.

The county has a wide range of skill sets represented among those county staff who contributed to the mitigation strategy section. The county has the ability to support implementation activities for the actions listed in this plan. The county staff also have the ability to support the small cities within the county to connect to funding sources and to implement mitigation work collaboratively.

Alsea updated its Emergency Response Plan (ERP) recently and has identified aspects of capacity for mitigation implementation including the facilities identified in the ERP.

Plan Maintenance

Plan maintenance is a critical component of the MNHMP. Proper maintenance of the plan ensures that this plan will maximize the county and participating city's and district's efforts to reduce the risks posed by natural hazards. This section includes an example of a process that can be used to ensure that a regular review and update of the plan occurs. The Steering Committee and local staff are responsible for implementing this process, in addition to maintaining and updating the plan through a series of meetings outlined in the maintenance schedule below.

Meetings

The Steering Committee will meet on a **semi-annual basis** (twice per year) to complete the following tasks. During the first meeting, prior to the wildfire/ irrigation season, the Steering Committee 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. The methodology described below is one way to do that prioritization.

The second meeting of the year will take place in early fall, following the wildfire/ irrigation season. During the second meeting the Steering Committee will:

- Review existing and new risk assessment data;
- Discuss methods for continued public involvement; and
- Document successes and lessons learned during the year.

These meetings are an opportunity for the county, cities and special district to report back to the group on progress that has been made on mitigation strategies within the MNHMP. The format of the plan allows the county and participating jurisdictions to review and update sections when new data becomes available. New data can be easily incorporated, resulting in a MNHMP that remains current and relevant to the participating jurisdictions.

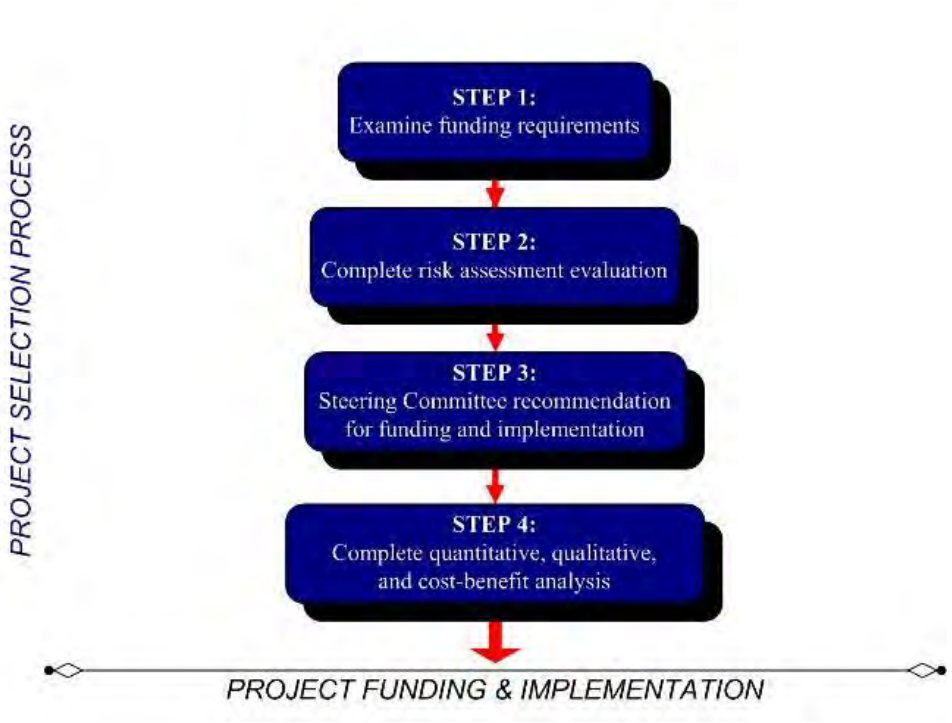
The convener will be responsible for documenting the outcome of the semi-annual meetings.

An example of a process the Steering Committee may use to prioritize mitigation projects is detailed in the section below.

Project Prioritization Process

The Disaster Mitigation Act of 2000 requires that jurisdictions identify a process for prioritizing potential actions. Potential mitigation activities often come from a variety of sources; therefore, the project prioritization process needs to be flexible. Committee members, local government staff, other planning documents, or the risk assessment may be the source to identify projects. Figure 4-1 illustrates the project development and prioritization process.

Figure 42. 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 to determine which funding sources are open for application. Several funding sources may be appropriate for the county's proposed mitigation projects. Examples of mitigation funding sources include but are not limited to: FEMA's Pre-Disaster Mitigation competitive grant program (PDM), Flood Mitigation Assistance (FMA) program, Hazard Mitigation Grant Program (HMGP), National Fire Plan (NFP), Community Development Block Grants (CDBG), local general funds, and private foundations, among others. Please see Appendix E, *Grant Programs and Resources* 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 which mitigation activities

would be eligible. The Coordinating Body may consult with the funding entity, Oregon Department of Emergency Management (OEM), 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: Complete risk assessment evaluation

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

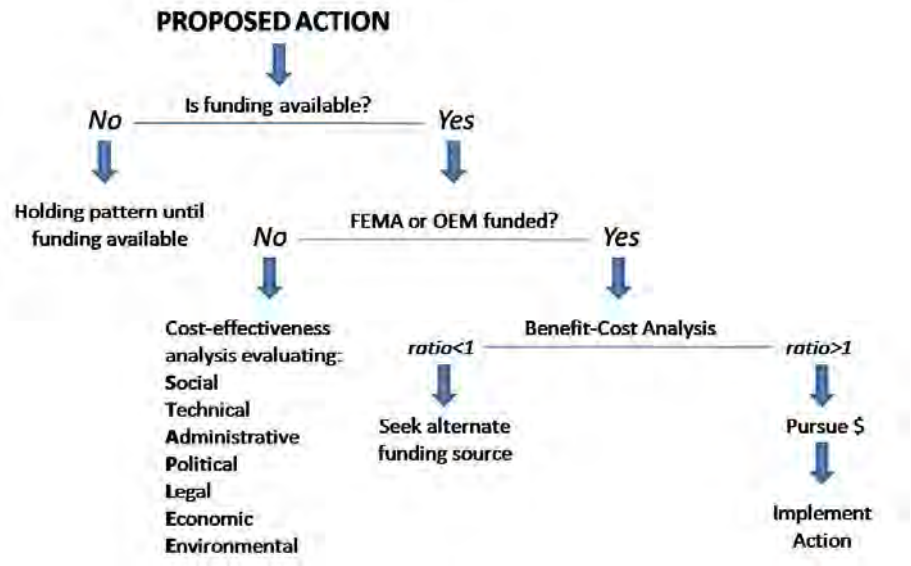
Step 3: Coordinating Body (Steering Committee) Recommendation

Based on the steps above, the Coordinating Body or Steering Committee 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 the issues surrounding grant applications and to share knowledge and/or resources. This process will afford greater coordination and less competition for limited funds.

Step 4: Complete quantitative and qualitative assessment, and economic analysis

The fourth step is to identify the costs and benefits associated with the selected natural hazard mitigation strategies, measures or projects. Two categories of analysis that are used in this step are: (1) benefit/cost analysis, and (2) cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity assists in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards provides decision makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects. Figure 4.2 shows decision criteria for selecting the appropriate method of analysis.

Figure 43. Benefit Cost Decision Criteria



Source: Oregon Partnership for Disaster Resilience, 2010.

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

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

Continued Public Involvement and Participation

The participating jurisdictions are dedicated to involving the public directly in the continual reshaping and updating of the Benton County MNHMP. 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.

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

- Post copies of their plans on corresponding websites;
- Place articles in the local newspaper or local newsletters informing the public about where to view information and provide feedback; and
- Use existing newsletters such as schools and utility bills to inform the public about where to view information and provide feedback.

In addition to the involvement activities listed above, Benton County will ensure continued public involvement by posting the Benton County MNHMP on the county's website within the Sheriff's Department Community Emergency Plans - Benton County Sheriff's Office, Oregon (bentoncountyor.gov)

Five-Year Review of Plan

This plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. **The Benton County NHMP is due to be updated by DATE, 2029.** The Convener will be responsible for organizing the Steering Committee to address plan update needs. The Steering Committee will be responsible for updating any deficiencies found in the plan, and for ultimately meeting the Disaster Mitigation Act of 2000's plan update requirements.

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

Table 4-1 Natural Hazards Mitigation Plan Update Toolkit

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

Source: Oregon Partnership for Disaster Resilience, 2010.