



DESCHUTES COUNTY MULTI-JURISDICTIONAL NATURAL HAZARDS MITIGATION PLAN

Report for:

Deschutes County
Bend
La Pine
Redmond
Sisters

Prepared by:

Central Oregon Intergovernmental Council

Community and Economic Development
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SPECIAL THANKS & ACKNOWLEDGEMENTS

Deschutes County developed this Multi-jurisdictional Natural Hazards Mitigation Plan (NHMP) through a regional partnership funded by the Federal Emergency Management Agency's Pre-Disaster Mitigation Competitive Grant Program. FEMA awarded the grant to support the update of the natural hazards mitigation plan. The county's planning process utilized a four-phased planning process, plan templates provided by Oregon Partnership for Disaster Resilience (OPDR) and plan development support provided by the Community and Economic Development Department of Central Oregon Intergovernmental Council (COIC). This project would not have been possible without technical and in-kind staff support provided by Deschutes County and the cities of Bend, La Pine, Redmond, and Sisters.

Partners include:

Deschutes County	FEMA Region X
City of Bend	City of La Pine
City of Redmond	City of Sisters
Oregon Military Department – Office of Emergency Management	
Central Oregon Intergovernmental Council	

Project Steering Committee:

Deschutes County

Representatives from the following organizations served as steering committee members for the Deschutes County natural hazards mitigation planning process.

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Roger Johnson	Fire Chief, Sisters-Camp Sherman Fire District
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About Central Oregon Intergovernmental Council

"COIC supports the region as a trusted leader and partner, helping communities identify and address their unique and common needs through collaboration, shared service delivery, technical assistance, information sharing, and resource development."

In 1972, COIC was designated a Council of Governments organized under ORS 190. We provide services to the counties of Crook, Deschutes and Jefferson, the cities of Bend, Culver, La Pine, Madras, Metolius, Prineville, Redmond and Sisters, as well as the Confederated Tribes of Warm Springs. Our offices are located throughout Central Oregon. COIC employs more than 100 people and services in the following areas: employment and training, alternative high school education, business loans, transportation, and community and economic development. The majority of the COIC Board is comprised of elected officials appointed by each of these member governments. Other appointed members of the Board represent timber and wood products, business and industry, under and unemployed, agribusiness and agriculture, and tourism and recreation.

For more information on COIC, visit www.coic.org

Plan Template Disclaimer

This Natural Hazards Mitigation Plan is based in part on a plan template developed by the Oregon Partnership for Disaster Resilience. The template is structured to address the requirements contained in 44 CFR 201.6; where language is applicable to communities throughout Oregon, OPDR encourages the use of standardized language. As part of this regional planning initiative, OPDR provided copies of the plan templates to communities for use in developing or updating their natural hazards mitigation plans. OPDR hereby authorizes the use of all content and language provided to Deschutes County in the plan template.

DESCHUTES COUNTY MULTI-JURISDICTIONAL NATURAL HAZARDS MITIGATION PLAN

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VOLUME I: BASIC PLAN

EXECUTIVE SUMMARY

Deschutes County developed this Multi-jurisdictional Natural Hazards Mitigation Plan (NHMP, MNHMP or Plan) in an effort to prepare for the long-term effects resulting from natural hazards. It is impossible to predict exactly when these hazards will occur, or the extent to which they will affect the community. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to create a resilient community that will benefit from long-term recovery planning efforts.

The Federal Emergency Management Agency (FEMA) defines mitigation as “. . . the effort to reduce loss of life and property by lessening the impact of disasters . . . through risk analysis, which results in information that provides a foundation for mitigation activities that reduce risk.” Said another way, natural hazard mitigation is a method of permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through

long and short-term strategies. Example strategies include policy changes, such as updated ordinances, projects, such as seismic retrofits to critical facilities; and education and outreach to targeted audiences, such as Spanish speaking residents or the elderly. Natural hazard mitigation is the responsibility of the “Whole Community” - individuals, private businesses and industries, state and local governments, and the federal government.

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

Why Develop this Mitigation Plan?

In addition to establishing a comprehensive community-level mitigation strategy, the Disaster Mitigation Act of 2000 (DMA2K) and the regulations contained in 44 CFR 201 require that jurisdictions maintain an approved Natural Hazard Mitigation Plan (NHMP) in order to receive federal funds for mitigation projects.

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

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

Who Participated in Developing the Plan?

The Deschutes County NHMP is the result of a collaborative effort between the county, cities, special districts, citizens, public agencies, non-profit organizations, the private sector and regional organizations. County and City steering committees guided the Plan development process. Surrounding counties were provided regular updates and opportunities for input.

The County Steering Committee included representatives from the following jurisdictions and agencies:

- Deschutes County
- City of Bend
- City of La Pine
- City of Redmond
- City of Sisters
- Oregon Department of Forestry
- OSU Extension
- Oregon Water Resources Department
- Sisters-Camp Sherman Fire
- Black Butte Ranch Fire
- Bend Fire & Rescue
- Sunriver Fire
- City of Redmond Police Department
- Crooked River Ranch
- National Weather Service – Pendleton
- Portland General Electric

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

The Deschutes County Sheriff’s Office Emergency Management Program convened the planning process and will take the lead in implementing, maintaining and updating the plan. Deschutes County is dedicated to directly involving the public in the continual review and update of the natural hazards mitigation plan. Although members of the Steering Committee represent the public to some extent, the public will also have the opportunity to continue to provide feedback about the Plan throughout the implementation and maintenance period.

The county will ensure continued public involvement by posting the NHMP on the County website, as well as on Central Oregon Intergovernmental Council’s project webpage here: <https://www.coic.org/emergency-preparedness/natural-hazard-mitigation-plans/deschutes-county-nhmp/>

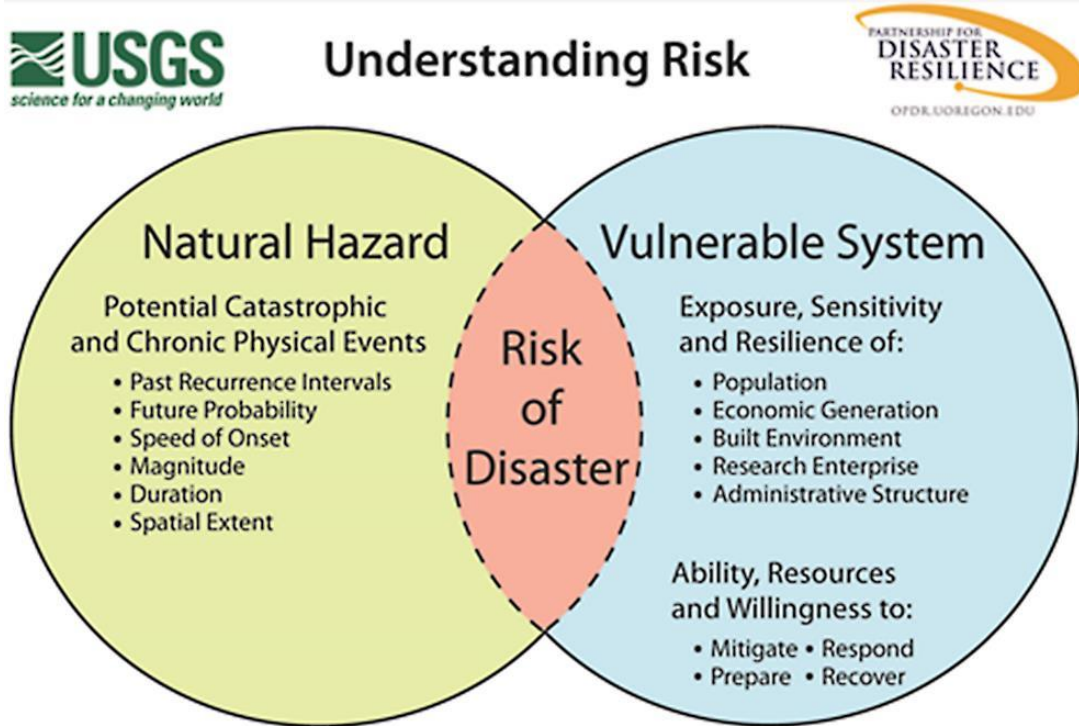
How Does this Mitigation Plan Reduce Risk?

The NHMP is intended to assist Deschutes County in reducing the risk from natural hazards by identifying resources, information, and strategies for risk reduction. It is also intended to guide and coordinate mitigation activities throughout the county. A risk assessment

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

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

Figure ES-I Understanding Risk



Source: Oregon Partnership for Disaster Resilience

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

What is the County’s Overall Risk to Hazards?

Deschutes County reviewed and updated their risk assessment to evaluate the probability of each hazard as well as the vulnerability of the community to that hazard. In addition, the steering committees for the participating cities reviewed the recently updated Deschutes County risk assessment to compare risk and vulnerability particular to their jurisdiction (see addenda for more information). Table ES-1 below summarizes hazard probability and vulnerability as determined by the county steering committee (for more information see Section 2, Risk Assessment).

Table ES-I Risk Assessment Summary

Hazard	Maximum				Total Threat Score	Hazard Rank
	History	Vulnerability	Threat	Probability		
Winter Storm	20	50	90	70	230	# 1
Wildfire	20	50	80	70	220	# 2
Windstorm	20	40	80	70	210	#3
Drought	20	15	70	70	175	#4
Volcano	2	50	100	21	173	#5
Earthquake (Cascadia)	2	40	100	7	149	#6
Flood	8	10	40	56	114	#7
Earthquake (Crustal)	2	20	80	7	109	# 8
Landslide	20	5	20	42	87	# 9

Source: Deschutes County NHMP Steering Committee, 2021

What is the Plan’s Mission?

The mission of the Deschutes County NHMP is to:

Mission: *To promote sound public policy designed to protect people, critical facilities, infrastructure, private property, and the environment from natural hazards.*

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

This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the county towards building a safer, more disaster resistant community.

What are the Plan Goals?

The Plan goals describe the overall direction that the participating jurisdiction’s agencies, organizations, and citizens can take toward mitigating risk from natural hazards. Below is a list of the plan goals (Note: although numbered the goals are not prioritized):

- Goal 1: Protect life and reduce injuries resulting from natural hazards.
- Goal 2: Minimize property damage from natural hazards.
- Goal 3: Minimize damage to critical or essential infrastructure and services from natural hazards.
- Goal 4: Enhance the ability of Deschutes County’s economy to rebound quickly from the effects of natural hazard events.
- Goal 5: Minimize project impacts to the environment and utilize natural solutions to protect people and property from natural hazards.
- Goal 6: Enhance the county’s capability to implement a comprehensive county wide natural hazards mitigation strategy.
- Goal 7: Motivate the “whole community” to build resilience and mitigate against the effects of natural hazards through engagement, listening, learning, information- sharing, and funding opportunities.
- Goal 8: Eliminate development within mapped hazardous areas where the risks to people and property cannot be practicably mitigated.

- Goal 9: Minimize damage to historic and cultural resources from natural hazards.
- Goal 10: Enhance communication, collaboration, and coordination among agencies at all levels of government, sovereign tribal nations, and the private sector to mitigate natural hazards.
- Goal 11: Mitigate the inequitable impacts of natural hazards by prioritizing and directing resources and investments to build resilience in the most vulnerable populations and the communities least able to respond and recover.
- Goal 12: Develop, integrate, and align natural hazards mitigation and climate adaptation efforts based on the evolving understanding of the interrelationships between climate change and climate-related natural hazard events.
- Goal 13: Reduce repetitive and severe repetitive flood losses.
- Goal 14: Minimize or eliminate potential impacts from dams posing the greatest risk to people, property, and infrastructure.

How are the Action Items Organized?

The action items are organized within an action matrix included within Section 3, Mitigation Strategy (full descriptions are provided in Appendix A, *Action Item Forms*).

Data collection, research and the public participation processes resulted in the development of the action items. The Action Item Matrix portrays the overall Plan framework and identifies linkages between the plan goals and actions. The matrix documents the title of each action along with the coordinating organization, timeline, and priority action items. Action items particular to each of the participating cities are included at the end of the action item matrix in Section 3, Mitigation Strategy and in the addenda.

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

How will the plan be implemented?

The plan maintenance section of this Plan details the formal process that will ensure that the Deschutes County NHMP remains an active and relevant document. The Plan will be implemented, maintained, and updated by a designated convener. The Deschutes County Emergency Services Manager is the designated convener (Plan Convener) and is responsible for overseeing the review and implementation processes. The Plan maintenance process includes a schedule for monitoring and evaluating the Plan semi-annually and producing a

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

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

plan revision every five years. This section also describes how the communities will integrate public participation throughout the plan maintenance process.

Plan Adoption

Once the Plan is locally reviewed and deemed complete the Plan Convener submits it to the State Hazard Mitigation Officer at the Oregon Military Department – Office of Emergency Management (OEM). OEM reviews the Plan and submits it to the Federal Emergency Management Agency (FEMA – Region X) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201.6. Once the Plan is pre-approved by FEMA, the county and cities formally adopt the Plan via resolution. The Deschutes County Plan Convener will be responsible for ensuring local adoption of the Deschutes County NHMP and providing the support necessary to ensure plan implementation. Once the resolution is executed at the local level and documentation is provided to FEMA, the Plan is formally acknowledged by FEMA and the County (and participating cities) and re-establishes eligibility for the Pre-Disaster Mitigation Grant Program, the Hazard Mitigation Grant Program funds, and the Flood Mitigation Assistance program funds.

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

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

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

The Steering Committees for Deschutes County and participating cities each met to review the Plan update process and their governing bodies adopted the NHMP as shown below:

The City of Sisters adopted the plan on October 13, 2021

Deschutes County adopted the plan on October 25, 2021

The City of La Pine adopted the plan on October 27, 2021.

The City of Bend adopted the plan on November 3, 2021

The City of Redmond adopted the plan on November 16, 2021

FEMA Region X approved the Deschutes County NHMP on October 28, 2021. With approval of this Plan, the entities listed above are now eligible to apply for the Robert T. Stafford Disaster Relief and Emergency Assistance Act’s hazard mitigation project grants through October 27, 2026.

SECTION I: INTRODUCTION

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

What is Natural Hazard Mitigation?

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, such as Spanish speaking residents or the elderly. Natural hazard mitigation is the responsibility of the “Whole Community” - individuals, private businesses and industries, 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 community through the planning process; and increased potential for state and federal funding for recovery and reconstruction projects.

Why Develop a Mitigation Plan?

Deschutes County developed this Natural Hazards Mitigation Plan (NHMP 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 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.

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

What Federal Requirements Does This Plan Address?

DMA2K is the latest federal legislation addressing mitigation planning. It reinforces the importance of mitigation planning and emphasizes planning for natural hazards before they occur. As such, this Act established the Pre-Disaster Mitigation (PDM) grant program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP). Section 322 of the Act specifically addresses mitigation planning at the state and local levels. State and local jurisdictions must have approved mitigation plans in place in order to qualify to receive post-disaster HMGP funds. Mitigation plans must demonstrate that 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 receive HMGP project grants.² Pursuant of Chapter 44 CFR, the Natural Hazard Mitigation Plan planning processes shall include opportunity for the public to comment on the plan during review, and the updated Natural Hazard Mitigation Plan shall 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 Military Department – Office of Emergency Management (OEM) for initial plan review, and then federal approval.⁵ Additionally, OEM administers the Emergency Management Performance Grant (EMPG), which helps fund local emergency management programs and 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 (Comprehensive Plans) and implementing ordinances that are required to comply with the statewide planning goals. The challenge faced by state and local governments is to keep this network of local plans coordinated in response to the changing conditions and needs of Oregon communities.

Statewide land use planning Goal 7: Areas Subject to Natural Hazards calls for local plans to include inventories, policies and ordinances to guide development in or away from hazard areas. Goal 7, along with other land use planning goals, has helped to reduce losses from natural hazards. Through risk identification and the recommendation of risk-reduction actions, this plan aligns with the goals of the jurisdiction's Comprehensive Plan, and helps each jurisdiction meet the requirements of statewide land use planning Goal 7.

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

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 Military Department – Office 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 Deschutes County Natural Hazard Mitigation Plan Steering Committee and the Steering Committees for the cities of Bend, La Pine, Redmond, and Sisters. The Deschutes County Steering Committee formally convened on four occasions to discuss and revise the plan. Each of the participating city Steering 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.

An open public involvement process is essential to the development of an effective plan. In order to develop a comprehensive approach to reducing the effects of natural disasters, the planning process shall include opportunity for the public, neighboring communities, local and regional agencies, as well as, private and non-profit entities to comment on the Plan during review.⁶ Central Oregon Intergovernmental Council (COIC) provided a publicly accessible project webpage for the general public in order to make meeting materials, the draft plan and contact information available throughout the update process. Additionally, COIC and Deschutes County hosted a virtual public input meeting on June 7th, 2021.

COIC and Deschutes County also administered a public opinion survey to obtain additional input from the public regarding the county's risks, vulnerabilities, hazards history, and mitigation strategies. See Appendix F for more information.

Finally, COIC sent quarterly updates to Emergency Services staff in the following neighboring communities with opportunities to participate and comment throughout the review process:

- Confederated Tribes of Warm Springs
- Lane County
- Klamath County
- Lake County
- Crook County
- Jefferson County

For more details and documentation of the public processes described above, see Appendix B.

⁶ Code of Federal Regulations, Chapter 44. Section 201.6, subsection (b). 2015

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 in synergy to create a mitigation plan that furthers the community's mission to reduce or eliminate long-term risk to people and their property from hazards and their effects. This plan structure enables stakeholders to use the section(s) of interest to them.

Volume I: Basic Plan

Executive Summary

The executive summary provides an overview of the FEMA requirements plans 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. (Additional information is included within Appendix C, which contains an overall description of Deschutes County and the cities of Bend, La Pine, Redmond, and Sisters). This section includes a brief description of community sensitivities and vulnerabilities and an overview of the hazards addressed in Volume II of this plan. The Risk Assessment allows readers to gain an understanding of the county's, and other jurisdictions', sensitivities – those community assets and characteristics that may be impacted by natural hazards, as well as the county's, and other jurisdictions', resilience – the ability to manage risk and adapt to hazard event impacts. 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 actions (mitigation strategy) and also describes the components that guide implementation of the identified actions. Actions are based on community sensitivity and resilience factors and the risk assessments in Section 2 and the Hazard Annexes (Volume II).

Section 4: Plan Implementation and Maintenance

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

Volume II: Hazard Annexes

The hazard annexes describe the risk assessment process and summarize the best available local hazard data. 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.

The hazard specific annexes included with this Plan are the following:

- Drought
- Earthquake
- Flood
- Landslide
- Volcanic Event
- Wildfire
- Windstorm, and
- Winter Storm

Volume III: Jurisdictional Addenda

Volume III of the plan is reserved for any city or special district addenda developed through this multi-jurisdictional planning process. Each of the cities with a FEMA approved addendum went through an update to coincide with the county's update. As such, the five-year update cycle will be the same for all of the cities and the county.

The Plan includes city addenda updates for the following jurisdictions:

- City of Bend
- City of La Pine
- City of Redmond
- City of Sisters

Volume IV: Mitigation Resources

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

Appendix A: Action Item Forms

This appendix contains the detailed action item forms for each of the mitigation strategies identified in Section 3 of this Plan.

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 any other public involvement methods.

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. Sensitivity factors can be defined as those community assets and characteristics that may be impacted by natural hazards, (e.g., special populations, economic factors, and historic and cultural resources). Community resilience factors can be defined as the community's ability to manage risk and adapt to hazard event impacts (e.g., governmental structure, agency missions and directives, and plans, policies, and programs).

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. The Oregon Partnership for Disaster Resilience developed this appendix. It has been reviewed and accepted by FEMA as a means of documenting how the prioritization of actions shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

Appendix E: Grant Programs and Resources

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

Appendix F: Deschutes County Natural Hazards Community Survey (2021)

Appendix F includes the survey instrument and results from the preparedness survey implemented by COIC and Deschutes County. The survey aims to gauge household knowledge of mitigation tools and techniques to assist in reducing the risk and loss from natural hazards, as well as assessing household disaster preparedness.

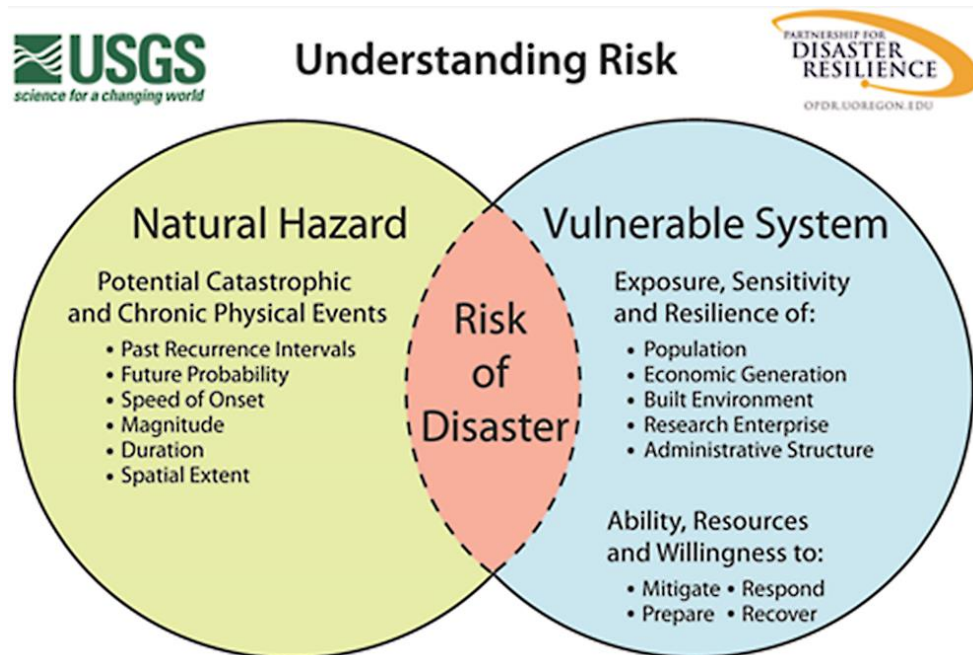
SECTION 2: RISK ASSESSMENT

This section of the NHMP addresses 44 CFR 201.6(b)(2) - Risk Assessment. In addition, this chapter can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – Areas Subject to Natural Hazards. Assessing natural hazard risk has three phases:

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

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

Figure 2-1 Understanding Risk

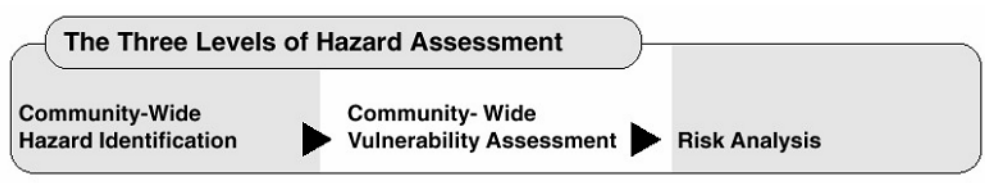


Source: Oregon Partnership for Disaster Resilience

What is a Risk Assessment?

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

Figure 2-2 Three Phases of a Risk Assessment



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

The first phase, **hazard identification**, involves the identification of the geographic extent of a hazard, its intensity, and its probability of occurrence. This level of assessment typically involves producing a map. The outputs from this phase can also be used for land use planning, management, and regulation; public awareness; defining areas for further study; and identifying properties or structures appropriate for acquisition or relocation.¹

The second phase, **vulnerability assessment**, combines the information from the hazard identification with an inventory of the existing (or planned) property and population exposed to a hazard, and attempts to predict how different types of property and population groups will be affected by the hazard. This step can also assist in justifying changes to building codes or development regulations, property acquisition programs, policies concerning critical and public facilities, taxation strategies for mitigating risk, and informational programs for members of the public who are at risk.²

The third phase, **risk analysis**, involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment, and (2) the likelihood or probability of the harm occurring. An example of a product that can assist communities in completing the risk analysis phase is HAZUS, a risk assessment software program for analyzing potential losses from floods, hurricane winds and earthquakes. In Hazards U.S. – Multi-Hazard (HAZUS-MH) current scientific and engineering knowledge is coupled with the latest geographic information systems (GIS) technology to produce estimates of hazard-related damage before, or after a disaster occurs.

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.

¹ Burby, *Cooperating with Nature* (Washington, DC: Joseph Henry Press, 1998), 126.

² Ibid, 133.

Hazard Analysis Methodology

This NHMP utilizes a hazard analysis methodology that was first developed by FEMA circa 1983, and gradually refined by the Oregon Military Department's Office 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%.

This 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 for category = 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 event 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 for category = 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 for category = 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 for category = 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

Hazard Identification

Deschutes County identifies eight natural hazards that could have an impact on the county (as shown in Table 2-1). For specific information pertaining to individual hazards, including location information, reference the Hazard Annexes (Volume II). Table 2-1 shows the hazards identified in the county in comparison to the hazards identified in the State of Oregon NHMP for Central Oregon (Region 6), which includes Deschutes County.

Table 2-1 Deschutes County Hazard Identification

Deschutes County	State of Oregon NHMP Region 6 Central Oregon
Drought	Drought
Earthquake	Earthquake
N/A	Extreme Heat
Flood	Flood
Landslide	Landslide
Volcano	Volcano
Wildfire	Wildfire
Windstorm	Windstorm
Winter Storm	Winter Storm

Source: Deschutes County NHMP Steering Committee (2021) and State of Oregon NHMP, Region 6: Central Oregon (2020)

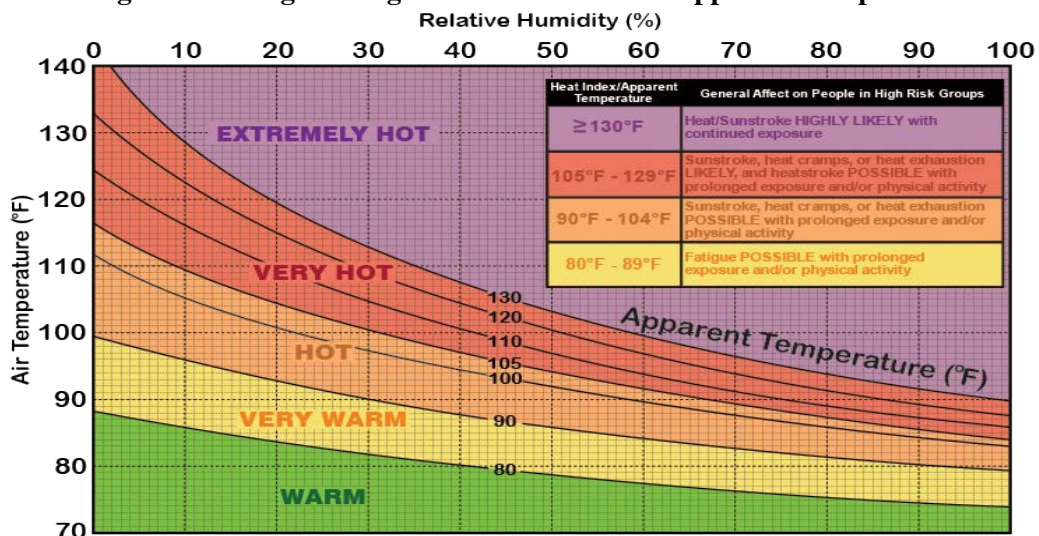
The extreme heat hazard is the only hazard identified in the state profile that is not perceived as a threat by the Deschutes NHMP steering committee. While Central Oregon is no stranger to hot days in the warm season (May – September), with temperatures frequently climbing to or exceeding 95 to 100 degrees (Fig. 2-2), these temperatures normally do not represent a major threat to the public. One consideration is the apparent temperature, or how the temperature actually feels when combined with humidity. Given the high desert climate of the region, humidity is often quite low (15% or less), leading the apparent temperature to be lower than the actual temperature. In such cases, the temperature actually feels cooler than it is due to the very low humidity. This lessens the danger of heat in these regions in the absence of higher humidity. In addition to low humidity leading to lower apparent temperatures, they also lend to rapidly cooling conditions during the overnight hours. It is not uncommon for some of the hottest days in Central Oregon to be coupled with cool nights where lows fall into the 50s and even 40s. This shortens the potential duration of heat events and related human exposure, making extreme heat a rather low risk in this region. This is not to say it cannot happen, but it is a rare occurrence. Figure 2-3 below illustrates danger levels associated with varying heat indices. The humidity is frequently too low to warrant extreme heat in Deschutes County.

Figure 2-2 Average Extreme Heat Days Per Year

Location	Average 95+ degree days per year	Average 100+ degree days per year
Bend	3.3	0.7 (once every 1.5 years)
Redmond Airport	12.7	2.8
Sisters	8.4	1.3
Sunriver	5	0.7 (once every 1.5 years)

Source: XMACIS 2000-2020

Figure 2-3 Danger Categories Associated with Apparent Temperature



Source: Marcus Austin, NOAA (2021)

Drought

A drought is a period of drier than normal conditions that results in water-related problems. 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.

For more information on the Drought Hazard (including history and extent) see the Drought Annex in Volume II.

Earthquake

Oregon and the Pacific Northwest in general are susceptible to earthquakes from four sources: 1) the off-shore Cascadia Fault Zone; 2) deep intra-plate events within the subducting Juan de Fuca Plate; 3) shallow crustal events within the North American Plate; and 4) earthquakes associated with volcanic activity.

The areas most susceptible to ground amplification and liquefaction have young, soft alluvial sediments, found along river and stream channels. The extent of the damage to structures and injury and death to people will depend upon the type of earthquake, proximity to the epicenter and the magnitude and duration of the event.

For more information on the Earthquake Hazard (including history and extent) see the Earthquake Annex in Volume II.

Flood

Flooding results when rain and snowmelt creates water flow that exceeds the carrying capacity of rivers, streams, channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall. Most of Oregon's destructive natural disasters have been floods.³ Flooding can be aggravated when rain is accompanied by snowmelt and frozen ground; the spring cycle of melting snow is the most common source of flood in the region. The principal types of flood that occur in Deschutes County include: spring/snowmelt flooding, warm winter rain-on-snow flooding, ice jams, flash floods, and dam failure.

For more information on the Flood Hazard (including history and extent) see the Flood Annex in Volume II.

Landslide

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

³ Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. 1999

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. Avalanches also occur in the mountainous west portion of the county; avalanches are similar to landslides except they involve snow and ice with some movement of rock or other debris.

For more information on the Landslide Hazard (including history and extent) see the Landslide Annex in Volume II.

Volcano

The Pacific Northwest lies within the “ring of fire,” an area of frequent volcanic activity surrounding the Pacific Basin. Volcanic events occur regularly along the ring of fire, in part because of the movement of the Earth’s tectonic plates. Volcanic events have the potential to coincide with numerous other hazards including ash fall, earthquakes, lava flows, pyroclastic flows, lahars, and debris flows, and landslides.

For more information on the Volcano Hazard (including history and extent) see the Volcano Annex in Volume II.

Wildfire

Wildfires occur in areas with large amounts of flammable vegetation that require a suppression response due to uncontrolled burning. Fire is an essential part of Oregon’s ecosystem, but can also pose a serious threat to life and property, particularly in the state’s growing rural communities. Wildfire can be divided into three categories: interface, wildland, and firestorms. The increase in residential development in interface areas has resulted in greater wildfire risk. Fire has historically been a natural wildland element and can sweep through vegetation that is adjacent to a combustible home. New residents in remote locations are often surprised to learn that in moving away from built-up urban areas, they have also left behind readily available fire services that provide structural protection.

For more information on the Wildfire Hazard (including history and extent) see the Wildfire Annex in Volume II.

Windstorm

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Although windstorms can affect the entirety of Deschutes 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.

For more information on the Windstorm Hazard (including history and extent) see the Windstorm Annex in Volume II.

Winter Storm

Severe winter storms can consist of rain, freezing rain, ice, snow, cold temperatures, and wind. They originate from troughs of low pressure offshore that ride along the jet stream during fall, winter, and early spring months. Severe winter storms affecting Deschutes County typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from November through March.

For more information on the Winter Storm Hazard (including history and extent) see the Winter Storm Annex in Volume II.

Federal Disaster and Emergency Declarations

Looking at the past events that have occurred 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 April 2021, FEMA has approved a total of 133 disaster declarations in Oregon.⁴ When governors ask for presidential declarations of major disaster or emergency, they stipulate which counties in their state they want included in the declaration. Table 2-2 summarizes the major disasters declared in Oregon that have affected Deschutes County, since 1955. The table shows that there have been three major disaster declarations for the county; all were weather-related.

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. There have been two emergency declarations that have affected Deschutes County.

Fire Management Assistance Grants (FMAG) 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 have been eleven fire management assistance declarations for the county (for a list of wildfires that have affected the county, between 1990 through 2021, see the Wildfire Hazard Annex in Volume II).

⁴FEMA, *Declared Disasters by Year or State*, http://www.fema.gov/news/disaster_totals_annual.fema. Accessed April 5, 2021.

Table 2-2 FEMA Major Disaster, Emergency, and Fire Management Declarations for Deschutes County

Declaration Number	Declaration Date	Incident Period		Incident	Individual Assistance	Public Assistance Categories
		From	To			
DR-184	12/24/1964	12/24/1964	12/24/1964	Heavy rains and flooding	Yes	A, B, C, D, E, F, G
DR-1510	2/19/2004	12/26/2003	1/14/2004	Severe Winter Storm	None	A, B, C, D, E, F, G
DR-4328	8/8/2017	1/7/2017	1/10/2017	Oregon Severe Winter Storms	None	B, E
EM-3039	4/29/1977	4/29/1977	4/29/1977	Drought	None	A, B
EM-3228	9/7/2005	8/29/2005	10/1/2005	Hurricane Katrina Evacuation	None	B
FMA-2034	7/25/1979	7/25/1979	-	Bridge Creek Fire	None	-
FMA-2035	7/26/1979	7/26/1979	-	Sisters Fire	None	-
FMA-2046	8/27/1984	8/27/1984	-	La Pine/Wampus Butte Fire	None	-
FMA-2075	8/5/1990	8/4/1990	-	Aubrey Hall Fire	None	-
FMA-2189	8/24/1996	8/24/1996	-	Skelton/Evans West Fire	None	B
FMA-2455	7/29/2002	7/28/2002	8/1/2002	Cache Mountain Fire	None	B
FMA-2493	8/20/2003	8/20/2003	10/22/2003	Booth Fire	None	B, H
FMA-2659	7/27/2006	7/27/2006	8/14/2006	Black Crater Fire	None	B, H
FMA-2727	9/3/2007	9/2/2007	9/11/2007	GW Fire	None	B, H
FMA-5056	6/8/2014	6/7/2014	6/14/2014	Two Bulls	None	-
FMA-5196	8/17/2017	8/16/2017	9/6/2017	Milii Fire	None	-

Source: FEMA, Oregon Disaster History. Major Disaster Declarations

Vulnerability Assessment

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.

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.⁵ Of this number, a disproportionate burden is placed upon special needs groups, particularly children, the elderly, the disabled, minorities, and low-income persons. Population vulnerabilities can be reduced or eliminated with proper outreach and community mitigation planning. For planning purposes, it is essential that Deschutes County and the cities of Bend, La Pine, Redmond, and Sisters

⁵ Hazards Workshop Session Summary #16, *Disasters, Diversity, and Equity*, University of Colorado, Boulder (2000).

consider both immediate and long-term socio-demographic implications of hazard resilience.

Population Vulnerabilities

- As of 2019, 19.6% of Deschutes County’s population is over the age of 64,⁶ a number that is projected to rise to 23.3% by 2035.⁷ Deschutes County’s elderly population is expected to grow to a slightly greater proportion of the population than Oregon as a whole which in 2020 had currently 18.7% of its population over the age of 64, with a projection of 22.5% by 2035.⁸
- The 2020 Deschutes County age dependency ratio is 57.1,⁹ which is higher than that of the State of Oregon (55.4); the age dependency figure for the county is expected to increase to 62.4 by the year 2035 (largely due to the growth in population over age 64), compared to 59.3 for the State of Oregon. As of 2019, La Pine has the highest age dependency ratio in the county (64.8).
- The cities of La Pine (19.2%) and Sisters (14.0%) have a high percentage of their populations over age 64 living alone.
- Even though the vast majority of the county population is reported as proficient in English, nearly 40% of Spanish speakers--the second most popular language spoken at home in the county--speak English “less than very well.” These populations would stand to benefit from mitigation outreach, with special attention to cultural, visual and technologically sensitive materials.
- Although the county has a median household income (\$67,043) almost exactly in line with the state (\$67,058); La Pine (\$37,991) has much lower median household income.
- The poverty rate of La Pine (16.8%) is almost double the county percentage (9.7%); Redmond’s poverty rate is 12.1%.
- La Pine has more than 20% of its population spending more than 35% of household income on housing (mortgage and 43% spending more than 35% of household income on rent.¹⁰
- Approximately 42% of La Pine’s population 65-74 years of age and 49% of those over 75 years of age have a disability.

⁶ Portland State University Population Research Center, Population Estimate Reports. 2020 Broad Age Groups by County. Accessed January 2021.

⁷ Portland State University Population Research Center, Population Forecasts. Deschutes County Final Forecast Tables. Accessed January 2021.

⁸ Portland State University Population Research Center, Population Forecasts. Oregon Final Forecast Table by Age. Accessed January 2021.

⁹ Dependency Ratio: the ratio of population typically not in the work force (less than 15, greater than 64); ratios have been calculated using Portland State University population data (current and forecasted).

¹⁰ U.S. Census Bureau, 2008-2012 American Community Survey, Tables B25070 & B25091.

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. A strong and diverse economic base increases the ability of individuals, families and the community to absorb disaster impacts for a quick recovery. It is imperative that Deschutes County and the cities of Bend, La Pine, Redmond, and Sisters recognize that economic diversification is a long-term issue; more immediate strategies to reduce vulnerability should focus on risk management for the dominant industries.

Economic Vulnerabilities

- According to the Oregon Employment Department, Deschutes County unemployment has decreased since 2014 when it was at 7.7% to 3.9% in 2019. It is important to note that the COVID-19 pandemic that began in 2020 likely had a drastic effect on employment rates, but annual data was not yet available at the time of writing. In the event of a large-scale disaster, unemployment has the potential to rise when businesses and companies are unable to overcome the ramifications of the hazard event.
- The largest sectors of employment in Deschutes County are Trade, Transportation, and Utilities (18.7%), Education and Health Services (16.5%), Leisure and Hospitality (15.7%), and Professional and Business Services (12.1%).¹¹
- The largest revenue sectors in Deschutes County are Retail Trade, Health Care and Social Assistance, and Wholesale Trade.¹² In the event of a natural disaster, large industries such as retail and wholesale trade may be significantly affected by a disaster as these basic industries tend to rely on a stable disposable income, which may decline following a disaster.
- In Central Oregon (Crook, Deschutes, and Jefferson Counties) the Construction (20%), Private Educational and Health Services (20%), and Information (19%) industries are expected to have the most growth from 2019 to 2029.¹³

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

¹¹ Oregon Employment Department, Current Employment Estimates (CES) 2019 <http://www.qualityinfo.org>. Accessed January 2021.

¹² U.S. Census Bureau, Economic Census 2017, Table EC1700BASIC.

¹³ Oregon Employment Department, East Cascades Industry Employment Projections 2019-2029. <http://www.qualityinfo.org>. Accessed January 2021.

support and provide space to live, work and recreate.¹⁴ 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

- Dynamic weather and relatively flat (east of the Cascades), arid land across Deschutes County are indicators of hazard vulnerability when combined with the changing climate and severe weather-related events. Both wet and dry cycles are likely to last longer and be more extreme, leading to periods of deeper drought and more frequent flooding. Less precipitation in the summers and subsequently lower soil moisture with hotter temperatures will likely increase the amount of vegetation consumed by wildfire.
- Extended drought periods affect snowpack and agricultural irrigation.
- The combination of a growing population and development intensification can lead to the increasing risk of hazards, threatening loss of life, property and long-term economic disruption if land management is inadequate.

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 of 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 could force communities to rely on local and immediately available resources.

Development

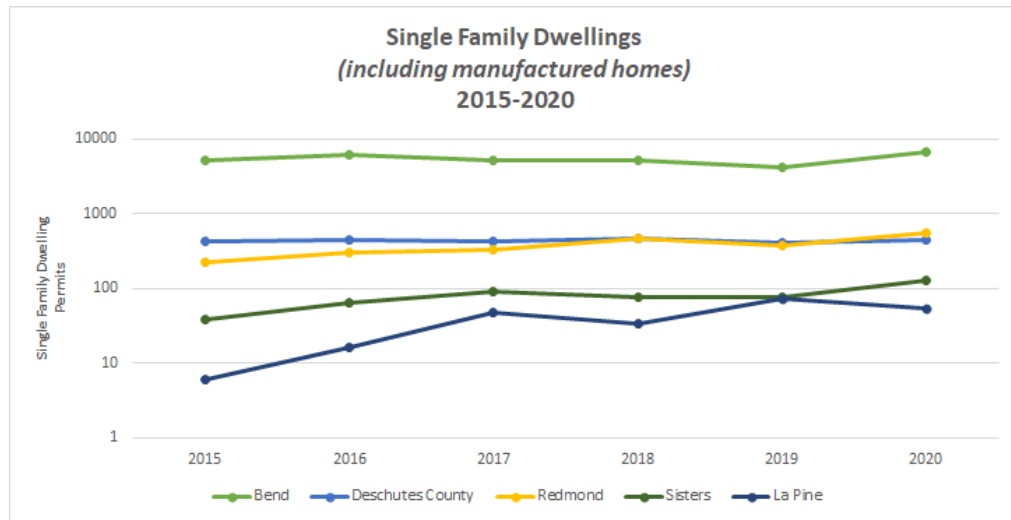
- Single-family development trends are generally stable or increasing across the jurisdictions in the past 5 years (figure 2-4 below).
- Notably, the Cities La Pine, Sisters, and Redmond have seen over a 9, 3, and 2-fold increase, respectively, in single-family building permits from 2015-2020 (figure 2-4 below).
- The Deschutes County Community Development Department (CDD) has coordinated efforts to establish planned communities with wildfire mitigation as a primary objective. In 2016, County staff facilitated the establishment of the Miller Tree Farm cluster development along the City of Bend's western Urban Growth Boundary. The Tree Farm development incorporates standards from the National Fire Protection Association (NFPA) and Firewise Communities for defensible space, fuel treatments, and construction material guidelines for all new development which occurs onsite. These standards are codified as conditions of approval for the

¹⁴ Mayunga, J. "Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. Summer Academy for Social Vulnerability and Resilience Building," (2007).

Tree Farm master plan, and ultimately serve as a benchmark for all residential developments which occur in the Wildland Urban Interface moving forward.

- In 2019 CDD led the adoption of a new zoning district in Deschutes County. The Westside Transect Zone (WTZ) serves as a transitional buffer between the City of Bend's western edge and heavily forested parcels further west. The WTZ is a unique zone in the County and serves as a major piece of compromise legislation between various interests in the region including developers, private property owners, environmental stewardship organizations, and wildfire protection officials. The WTZ incorporates National Fire Protection Association (NFPA) and Firewise Communities standards for all new development. All land divisions which occur in the WTZ are required to submit Wildfire Mitigation Plans prepared by a professional forester, which outline the specific wildfire risks within the subdivision area, and must include direct strategies for mitigating those risks. Mitigation strategies can include a defensible space program for individual properties, roofing and other fire-resistant building material standards, and road access requirements for citizens and firefighting personnel. Measures outlined in individual Wildfire Mitigation Plans are ultimately included as conditions of approval and upheld by designated Homeowners Associations. These plans and designated mitigation actions must be evaluated on a regular basis or at the request of CDD. This ensures that any changes to wildfire risk are adequately captured and factored into new and existing development plans.
- In April 2020, the Deschutes County Wildfire Mitigation Advisory Committee presented a report to the Deschutes County Board of Commissioners with recommendations for adoption of new fire-resistant building standards, possible County-wide defensible space programs for residential development, and updates to the adopted Deschutes County Wildfire Hazard Zone. The fire-resistant building standards are based on the Oregon Building Codes Division's (BCD) updated Wildfire Hazard Mitigation standards, also known as ORSC - R327. Ultimately, CDD staff found that a majority of citizen respondents were supportive of additional building or defensible space requirements to reduce wildfire risk in Deschutes County. The results of the public outreach effort were presented to the Deschutes County Board of Commissioners in February 2021 along with a timeline for future steps to further evaluate these issues.

Figure 2-4 Deschutes County Single Family Dwellings (Permits)



Source: Deschutes County Community Development Department, 2021

Housing Vulnerabilities

- It is crucial to maintain the quality of built capacity (transportation networks, critical facilities, utility transmission, etc.) throughout the area, as poor infrastructure can negatively affect Deschutes County’s ability to cope, respond, and recover from a natural disaster.
- Mobile homes and other non-permanent residential structures account for 7% of the housing in Deschutes County. In La Pine, mobile homes account for more than 12% of all homes; in Sisters, that figure is 4.6%; Redmond, 4.7%; Bend, 5.6%.¹⁵ These structures are particularly vulnerable to certain natural hazards, such as windstorms and heavy flooding events.
- Based on U.S. Census data, almost 60% of the residential housing throughout Deschutes County was built after the current seismic building standards of 1990.¹⁶
- Approximately one-third of residential structures were constructed prior to the local implementation of the flood elevation requirements of the 1970s (county Flood Insurance Rate Maps –FIRMs- were not completed until the mid-1980s).¹⁷
- The county has one-third of its housing units occupied by renters, versus two-thirds owner-occupied.¹⁸ The cities of La Pine and Sisters have around 50% of their housing occupied by renters (La Pine 45%). Studies have shown that renters are less likely than homeowners to prepare for hazardous events.

¹⁵ U.S. Census Bureau, 2019 American Community Survey 1- and 5- Year Estimates Data Profiles, Table DP04.

¹⁶ Ibid.

¹⁷ Ibid.

¹⁸ Ibid.

- The cities of La Pine (8.3%) and Sisters (21.2%) have the highest percentages of vacant units. County-wide, more than three-fourths of all vacant housing units can be attributed to seasonal or recreational housing; this is likely due to the large number of destination resorts and resort communities in Deschutes County, including Black Butte Ranch, Eagle Crest and Sunriver.¹⁹

Critical Facilities and Infrastructure Vulnerabilities

- Some roads and bridges in the county are highly vulnerable to hazards, specifically earthquakes. Because bridges vary in size, materials, siting, and design, any given hazard will affect them differently. The county and cities should pay considerable attention to roads and bridges that may become obstructed that serve as primary interstate travel routes (Highways 97, 20/126), as this will likely have significant impacts on access in and out of the county and region. Oregon Department of Transportation has jurisdiction over highways, but the cities and county may control maintenance in and around the communities.
- Several solar power facilities have been approved and constructed in Deschutes County. There is one power plant within Deschutes County; a Pacific Power station at Mirror Pond Dam in Bend operated by Pacific Power.
- There are five dams categorized as high hazard; North Canal Diversion, Crescent Lake, Crane Prairie Dam, Wickiup Dam, and the Sunriver Effluent Lagoon. In addition, the moraine lake dam on Whychus Creek (Carver Lake) above Sisters is identified as a potential flood concern, particularly with respect to impacts to the City of Sisters Wastewater Treatment Facility (see Flood Hazard Annex in Volume II and Sisters Addendum in Volume III for more information).

National Flood Insurance Program (NFIP)

The Deschutes County Flood Insurance Rate Maps (FIRMs) were modernized in September 2007. The table below shows that as of January 2021, Deschutes County (including the incorporated cities) has 218 National Flood Insurance Program (NFIP) policies in force and eleven paid claims. The last Community Assistance Visit (CAV) for Deschutes County was on July 22, 1994 (the most recent CAV was in Sisters on April 26, 2004). The county, and cities, are not members of the Community Rating System (CRS). The table displays the number of policies by building type and shows that the majority of residential structures that have flood insurance policies are single-family homes and that there are 11 non-residential structures with flood insurance policies. According to data from 2021, the proportion of single-family homes (excluding condominiums) within the mapped special flood hazard area (SFHA, floodplain) that have flood insurance (the market penetration rate) for Deschutes County is 12.7%.

The Community Repetitive Loss record for Deschutes County, Bend, La Pine, Redmond, and Sisters identifies zero repetitive loss buildings, zero severe repetitive loss buildings, and zero total repetitive loss claims.

¹⁹ Ibid, Table B25004.

Table 2-3 Flood Insurance Detail

Jurisdiction	Current FIRM Date	Initial FIRM Date	Total Policies	Pre-FIRM Policies	Policies by Building Type				Minus Rated A Zone
					Single Family	2 to 4 Family	Other Residential	Non-Residential	
Deschutes	-	-	218	90	208	3	1	1	14
County*	9/28/2007	9/29/1986	126	66	126	0	0	0	11
Bend	9/28/2007	9/4/1987	60	21	50	3	1	1	1
La Pine	9/28/2007	9/28/2007	1	1	1	0	0	0	0
Redmond	9/28/2007	9/28/2007	0	0	0	0	0	0	0
Sisters	9/28/2007	9/29/1986	31	2	31	0	0	0	2

Jurisdiction	Insurance in Force	Total Paid Claims	Pre-FIRM Claims Paid	Substantial Damage Claims	Repetitive Loss Buildings	Severe Repetitive Loss Buildings	Total Paid Amount	CRS Class Rating	Last CAV
County*	\$36,129,300	3	1	0	1	0	\$15,115	NP	7/22/1994
Bend	\$21,792,700	5	4	0	0	0	\$50,392	NP	7/20/1994
La Pine	\$280,000	0	0	0	0	0	\$0	NP	NA
Redmond	\$0	0	0	0	0	0	\$0	NP	NA
Sisters	\$9,689,200	0	0	0	0	0	\$0	NP	4/26/2004

* Portion of entire county under county jurisdiction
 NP - Not Participating NA - Information not Available/ Not Applicable

Source: Information compiled by FEMA, January 2021

Vulnerability Summary

Vulnerability is a measure of the exposure of the built environment 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 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. Deschutes County and the cities of Bend, La Pine, Redmond, and Sisters evaluated the best available vulnerability data to develop the vulnerability scores presented below. For the purposes of this Plan, the county and cities utilized the Oregon Military Department – Office of Emergency Management (OEM) Hazard Analysis methodology vulnerability definitions to determine hazard probability.

The table below presents the vulnerability scores for each of the natural hazards present in Deschutes County and for participating cities. As shown in the table with **bold text**, several hazards are rated with high vulnerabilities.

Table 2-4 Community Vulnerability Assessment Summary

Hazard	Deschutes County	Bend	La Pine	Redmond	Sisters
Drought	Low	Low	Moderate	Low	Low
Earthquake (Cascadia)	High	High	High	High	High
Earthquake (Crustal)	Moderate	Moderate	Moderate	Moderate	Moderate
Flood	Low	Moderate	High	Low	High
Landslide	Low	Low	Low	Low	Low
Volcano	High	High	High	High	High
Wildfire	High	High	High	High	High
Windstorm	High	Moderate	High	Moderate	High
Winter Storm	High	High	High	High	High

Source: Deschutes County, Bend, La Pine, Redmond, and Sisters NHMP Steering Committees, 2021

Risk Analysis

The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section), and (2) the likelihood or probability of the harm occurring. The table below presents the probability scores for each of the natural hazards present in Deschutes County and for the participating cities. As shown in the table with **bold text**, several hazards are rated with high probabilities.

Table 2-5 Natural Hazard Probability Assessment Summary

Hazard	Deschutes County	Bend	La Pine	Redmond	Sisters
Drought	High	High	Moderate	High	High
Earthquake (Cascadia)	Low	Low	Low	Low	Low
Earthquake (Crustal)	Low	Low	Low	Low	Low
Flood	High	High	Low	Low	High
Landslide	Low	Low	Low	Low	Low
Volcano	Low	Low	Low	Low	Low
Wildfire	High	High	High	Moderate	High
Windstorm	High	High	High	High	High
Winter Storm	High	High	High	High	High

Source: Deschutes County, Bend, La Pine, Redmond, and Sisters NHMP Steering Committees, 2021.

The table below presents the entire updated hazard analysis matrix for Deschutes County. The hazards are listed in rank order from high to low. The table shows that hazard scores are influenced by each of the four categories combined. With considerations for past historical events, the probability or likelihood of a particular hazard event occurring, the vulnerability to the community, and the maximum threat or worst-case scenario, winter storm, wildfire, and windstorm events rank as the top hazard threats to the county. Droughts, volcanic events, and Cascadia Earthquake rank in the middle. Flood, crustal earthquakes, and landslides comprise the lowest ranked hazards in the county.

Table 2-6 Hazard Analysis Matrix – Deschutes County

Hazard	Maximum				Total Threat Score	Hazard Rank
	History	Vulnerability	Threat	Probability		
Winter Storm	20	50	90	70	230	# 1
Wildfire	20	50	80	70	220	# 2
Windstorm	20	40	80	70	210	#3
Drought	20	15	70	70	175	#4
Volcano	2	50	100	21	173	#5
Earthquake (Cascadia)	2	40	100	7	149	#6
Flood	8	10	40	56	114	#7
Earthquake (Crustal)	2	20	80	7	109	# 8
Landslide	20	5	20	42	87	# 9

Source: Deschutes County NHMP Steering Committee, 2021

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

Multi-Jurisdictional Risk Assessment

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

The four participating cities in Deschutes County: Bend, La Pine, Redmond, and Sisters each held local Steering Committee meetings and completed a jurisdiction specific hazard analysis. The multi-jurisdictional risk assessment information is located within the Risk Assessment section of each city’s addendum, which is located in Volume III of this NHMP.

SECTION 3: MITIGATION STRATEGY

Section 3 outlines Deschutes 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.

Mitigation Plan Mission

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

The mission of the Deschutes County NHMP is:

To promote sound public policy designed to protect people, critical facilities, infrastructure, private property, and the environment from natural hazards.

This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the county towards building a safer, more disaster resistant community.

The 2021 NHMP Steering Committee reviewed the 2015 plan mission statement and agreed it accurately describes the overall purpose and intent of this Plan. This is almost the exact wording that was present in the 2015 plan, with the minor change from “protect citizens” to “protect people.” The Steering Committee recognizes that Central Oregon receives many visitors as a tourism destination. The change captures all persons located in, visiting, or planning to visit Deschutes County. The Steering Committee believes the concise nature of the mission statement allows for a comprehensive approach to mitigation planning.

Mitigation Plan Goals

Mitigation plan goals are more specific statements of direction that Deschutes 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 for agencies and organizations to begin implementing mitigation action items.

The 2021 Deschutes County NHMP Steering Committee reviewed the 2015 plan goals in comparison to the 2020 State Natural Hazard Mitigation Plan goals and determined they would modify their goals to align with the latest State Natural Hazard Mitigation Plan goals.

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 to implement first, should funding become available. Below is a list of the plan goals:

- Goal 1: Protect life and reduce injuries resulting from natural hazards.
- Goal 2: Minimize property damage from natural hazards.
- Goal 3: Minimize damage to critical or essential infrastructure and services from natural hazards.
- Goal 4: Enhance the ability of Deschutes County's economy to rebound quickly from the effects of natural hazard events.
- Goal 5: Minimize project impacts to the environment and utilize natural solutions to protect people and property from natural hazards.
- Goal 6: Enhance the county's capability to implement a comprehensive county wide natural hazards mitigation strategy.
- Goal 7: Motivate the "whole community" to build resilience and mitigate against the effects of natural hazards through engagement, listening, learning, information-sharing, and funding opportunities.
- Goal 8: Eliminate development within mapped hazardous areas where the risks to people and property cannot be practicably mitigated.
- Goal 9: Minimize damage to historic and cultural resources from natural hazards.
- Goal 10: Enhance communication, collaboration, and coordination among agencies at all levels of government, sovereign tribal nations, and the private sector to mitigate natural hazards.
- Goal 11: Mitigate the inequitable impacts of natural hazards by prioritizing and directing resources and investments to build resilience in the most vulnerable populations and the communities least able to respond and recover.
- Goal 12: Develop, integrate, and align natural hazards mitigation and climate adaptation efforts based on the evolving understanding of the interrelationships between climate change and climate-related natural hazard events.
- Goal 13: Reduce repetitive and severe repetitive flood losses.
- Goal 14: Minimize or eliminate potential impacts from dams posing the greatest risk to people, property, and infrastructure.

(Note: although numbered the goals are not prioritized.)

During the Steering Committee meetings for the participating jurisdictions (Bend, La Pine, Redmond, and Sisters) the Deschutes County NHMP mission statement and goal statements were reviewed and agreed upon by each community.

Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by the county in an effort to reduce the community's overall risk to natural hazards. Documenting these efforts can assist the jurisdiction to better understand risk and can assist in documenting successes. For a comprehensive list of existing mitigation activities for each specific hazard, reference Volume II, Hazard Annexes.

Government Structure

Beyond Emergency Management, most departments within the county and city governance structures have some degree of responsibility in building overall community resilience. Each plays a role in ensuring that jurisdiction functions and normal operations resume after an incident, and the needs of the population are met. For further explanation regarding how these departments influence hazard resilience, reference Appendix C, Community Profile and within the city addenda of Volume III.

Existing Plans and Policies

Communities often have existing plans and policies that guide and influence land use, land development, and population growth. Linking existing plans and policies to the NHMP helps identify what resources already exist that can be used to implement the action items identified in the Plan. Plans and policies already in existence have support from local residents, businesses and policy makers.¹ A list documenting plans and policies already in place in the county and participating cities can be found in Appendix C, Community Profile and within the city addenda of Volume III.

Community Organizations and Programs

In planning for natural hazard mitigation, it is important to know what social systems already exist within the community because of their existing connections to the public. The county and cities can use existing social systems as resources for implementing such communication-related activities because these service providers already work directly with the public on a number of issues, one of which could be natural hazard preparedness and mitigation. Appendix C, Community Profile, provides a comprehensive list of community organizations and programs, and offers a more thorough explanation of how existing community organizations and programs can be utilized for hazard mitigation.

Mitigation Plan Action Items

Action items identified through the planning process are an important part of the mitigation plan. Action items are detailed recommendations for activities that local departments, citizens and others could engage in to reduce risk. They address both multi-hazard (MH) and hazard-specific issues. Action items can be developed through a number of sources such as local reports and plans, community stakeholder engagement processes, surveys, and committee work sessions. description of how the Plan’s mitigation actions were developed is provided below.

¹ Raymond J. Burby, “Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities,” (1998).

Action Item Worksheets

Each action item has a corresponding action item worksheet describing the activity, identifying the rationale for the project, identifying potential ideas for implementation, and assigning coordinating and partner organizations. The action item worksheets can assist the community in pre-packaging potential projects for grant funding. The worksheet components are described below. These action item worksheets are located in Appendix A, Action Item Forms.

Proposed Action Title

Each action item includes a brief description of the proposed action.

Alignment with Plan Goals

The Plan goals addressed by each action item are identified as a means for monitoring and evaluating how well the mitigation plan is achieving its goals, following implementation.

Affected Jurisdiction/s

Many of the action items within this Plan apply to all of the participating cities and the county; however, some action items are specific. The list of affected jurisdictions is provided on the right side of the matrix. Each city identified as an “affected jurisdiction” will contribute to accomplishing the specified action at a local level. The action item form in Appendix A provides more detailed information.

Alignment with Existing Plans/Policies

Identify any existing community plans and policies where the action item can be incorporated. Incorporating the mitigation action into existing plans and policies, such as comprehensive plans, will increase the likelihood that it will be implemented.

The Deschutes County NHMP includes a range of action items that, when implemented, will reduce loss from hazard events in the County. Within the Plan, FEMA requires the identification of existing programs that might be used to implement these action items. Deschutes County and the participating cities currently address statewide planning goals and legislative requirements through their comprehensive land use plans, capital improvements plans, mandated standards, and building codes. To the extent possible, the jurisdictions will work to incorporate the recommended mitigation action items into existing programs and procedures. (Note: Deschutes County is currently participating in a review of their development code to determine options for improvement regarding the flood and wildfire hazards.)

Many of the recommendations contained in the Deschutes County NHMP are consistent with the goals and objectives of the existing plans and policies. Where possible, Deschutes County and the participating cities will implement the recommendations and actions contained in the NHMP through existing plans and policies. Plans and policies already in existence 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.² Implementing the action items contained in the NHMP through such plans and policies increases their likelihood of being supported and implemented.

Rationale or Key Issues Addressed

Action items should be fact-based and tied directly to issues or needs identified throughout the planning process. Action items can be developed at any time during the planning process and can come from a number of sources, including participants in the planning process, noted deficiencies in local capability, or issues identified through the risk assessment. The rationale for proposed action items is based on the information documented in Section II and the Hazard Annexes.

Ideas for Implementation

The ideas for implementation offer a transition from theory to practice and serve as a starting point for this Plan. This component of the action item is dynamic, since some ideas may prove to not be feasible, and new ideas may be added during the plan maintenance process. Ideas for implementation include such things as collaboration with relevant organizations, grant programs, tax incentives, human resources, education and outreach, research, and physical manipulation of buildings and infrastructure.

Coordinating (Lead) Organization

The coordinating organization is the public agency with the regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring and evaluation.

Internal and External Partners

The internal and external partner organizations listed in the Action Item Worksheets are potential partners recommended by the project Steering Committee but not necessarily contacted during the development of the Plan. The coordinating organization should contact the identified partner organizations to see if they are capable of and interested in participation. This initial contact is also to gain a commitment of time and/or resources toward completion of the action items.

Internal partner organizations are departments within the county or other participating jurisdiction that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization.

External partner organizations can assist the coordinating organization in implementing the action items in various functions and may include local, regional, state, or federal agencies, as well as local and regional public and private sector organizations.

² Ibid

Potential Funding Sources

Where possible, identify potential funding sources for the action item. Example funding sources can include: the federal Pre-Disaster Mitigation and Flood Mitigation Assistance Programs; state funding sources such as the Oregon Seismic Rehabilitation Grant Program; or local funding sources such as capital improvement or general funds. An action item may also have multiple funding sources.

Estimated Cost

A rough estimate of the cost for implementing each action item is included. Costs are shown in general categories showing low, medium, or high cost. The estimated cost for each category is outlined below:

Low – Less than \$50,000

Medium - \$50,000 - \$100,000

High – More than \$100,000

Timeline

Action items include both short and long-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term action items* (ST) are activities that may be implemented with existing resources and authorities in one to two years. *Medium-term action items* (MT) may require some resource development and coordination and may take 2-5 years. *Long-term action items* (LT) may require new or additional resources and/or authorities, and may take from one to five years to implement. *Ongoing* action items signify that work has begun and will either exist over an indefinite timeline, or an extended timeline.

Status

As action items are implemented or new ones are created during the Plan maintenance process, it is important to indicate the status of the action item—whether it is new, ongoing, deferred, or complete. Documenting the status of the action will make reviewing and updating the mitigation Plan easier during the Plan’s five-year update, and can be used as a benchmark for progress. *Deferred* action items have yet to see any significant work begin on the particular action.

Priority

High priority action items are designated in order to clarify the importance of these mitigation actions for the affected jurisdictions.

Action Item Development Process

Development of action items was a multi-step, iterative process that involved brainstorming, discussion, review, and revisions. The majority of the action items were first created during the 2005 and 2010 NHMP planning processes. During those processes, steering committees developed maps 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. In 2015, The Oregon Partnership for Disaster Resilience (OPDR) provided guidance in the development of action items by presenting and discussing actions that were used in other communities. OPDR also took note of ideas that came up in Steering Committee meetings and drafted specific actions that met the intent of the Steering Committee. All actions were then reviewed by the Steering Committee, discussed at length, and revised as necessary before becoming a part of this document. In 2021, the Steering Committee reviewed the 2015 action items to provide a status update. New action items were developed by Steering Committee members and approved by the full group throughout the update process.

Action Item Matrix

The action item matrix portrays the overall action plan framework and identifies linkages between the Plan goals, partnerships (coordination and partner organizations), and actions. The matrix documents a description of the action, if the Steering Committee identified the action as high priority, the coordinating organization, partner organizations, timeline, and the Plan goals addressed. Refer to Appendix A, Action Item Forms for detailed information about each action item.

Table 3-1 Deschutes County Action Items

2021 Action Item	Priority	Proposed Action Title	Lead Agency	Partner Organization(s)	Timeline	Status	Jurisdictions					
							Deschutes County	Bend	La Pine	Redmond	Sisters	
Multihazard #1		Integrate training and education initiatives from the Deschutes County Natural Hazards Mitigation Plan into existing regulatory documents and programs where appropriate.	Deschutes County Natural Hazards Mitigation Committee	<u>Internal:</u> Emergency Services, Community Development, County Forester, Road Department, Public Works, Cities; <u>External:</u> ODF, American Red Cross, OSU Cascades	Ongoing	Ongoing	X	X	X	X	X	
MH #2		Pursue coordination of mitigation initiative development, planning, and resource allocation (funding).	Deschutes County Natural Hazards Mitigation Committee	<u>Internal:</u> Emergency Services, Community Development, County Forester, Road Department, Public Works; <u>External:</u> ODF, American Red Cross, OSU Cascades, USFS	Ongoing	Ongoing	X	X	X	X	X	
MH #3		Strengthen understanding of the probability of natural hazards by continuing to support research specific to the region.	Deschutes County Natural Hazards Mitigation Committee	<u>Internal:</u> - <u>External:</u> OSU Cascades, DOGAMI, USGS, ACOE, FEMA, DLCD, OEM, University of Oregon	Ongoing	Ongoing	X	X	X	X	X	
MH #4	X	Assess power grid and determine methods to improve resiliency and encourage community preparedness for power loss.	Deschutes County Emergency Services	<u>Internal:</u> Public Works: Planning/Roads, Deschutes County Health Services <u>External:</u> Utility Providers, U.S. DOE, OEM, OHA	Long Term	Ongoing	X	X	X	X	X	
MH #5	X	Develop continuity of operations plans to ensure continued operation in the event of a natural hazard emergency.	Deschutes County Emergency Services	<u>Internal:</u> Public Works, Planning, Roads; <u>External:</u> OEM	Long Term	Ongoing	X	X	X	X	X	
MH #6		Develop code language to mitigate the harmful impact of hazard trees located on private and/ or vacant property.	Deschutes County Emergency Services	<u>Internal:</u> County Forester, Community Development, Public Works <u>External:</u> Electric Utilities, ODF	Long Term	New	X	X	X	X	X	
MH #7		Continue and enhance windstorm resistant construction methods where possible to reduce damage to utilities and critical facilities from windstorms. In part, this may be accomplished by encouraging electric utility providers to convert existing overhead lines to underground lines.	Deschutes County Emergency Services	<u>Internal:</u> Community Development, City Community Development/ Planning, and Public Works <u>External:</u> Electric Utilities	Long Term	Ongoing	X	X	X	X	X	

Source Deschutes County NHMP Steering Committee, updated 2021

Table 3-1 Deschutes County Action Items (Continued)

2021 Action Item	Priority	Proposed Action Title	Lead Agency	Partner Organization(s)	Timeline	Status	Jurisdictions				
							Deschutes County	Bend	La Pine	Redmond	Sisters
MH #8	X	Identify, inventory and prioritize hardening of critical communications infrastructure.	Deschutes County Emergency Services	<u>Internal:</u> Deschutes County 911, Deschutes County Forester/Project Wildfire, Deschutes County Information Technology/GIS <u>External:</u> ODOT, ODF, USFS, BLM, private landowners, private infrastructure owners	Medium Term	NEW	X	X	X	X	X
MH #9		Support the development and coordination of the Regional Emergency Services Training and Coordination Center (RESTCC)	Central Oregon Intergovernmental Council	<u>Internal:</u> DCSO, Board of County Commissioners, Cities, Special Service Districts <u>External:</u> OEM, OSFM, ODF, OSP, DPSST, Governor’s Office Regional Solutions, Central Oregon Fire Management Services (COFMS), Crook County, Jefferson County, Central Oregon Fire Chief’s Association (COFCA), Central Oregon Law Enforcement Services (COLES)	Long Term	NEW	X	X	X	X	X
Drought	No action items are identified specific to this hazard. However, several multi-hazard action items address this hazard.										
Earthquake #1		Support development of in-depth studies to determine county and region’s vulnerability to earthquake.	Deschutes County Emergency Services	<u>Internal:</u> Community Development <u>External:</u> FEMA, DOGAMI, OEM, USGS, OSU Cascades	Long Term	Deferred	X	X	X	X	X
EQ #2		Seismically retrofit vulnerable facilities and infrastructure to increase their resiliency to seismic hazards. Consider both structural and non-structural retrofit options.	Deschutes County Natural Hazards Mitigation Committee	<u>Internal:</u> Public Works, Community Development, Building, Fire, Police, Sheriff <u>External:</u> Deschutes County School Districts, OEM, DOGAMI, FEMA, ODE, IFA, SHPO	Long Term	Ongoing	X	X	X	X	X

Source: Deschutes County NHMP Steering Committee, updated 2021

Table 3-1 Deschutes County Action Items (Continued)

2021 Action Item	Priority	Proposed Action Title	Lead Agency	Partner Organization(s)	Timeline	Status	Jurisdictions				
							Deschutes County	Bend	La Pine	Redmond	Sisters
EQ #3		Develop outreach strategy and increase public awareness of ShakeAlert Early Warning System in Deschutes County.	Deschutes County Emergency Services	<u>Internal:</u> Deschutes County Health Services, Deschutes County Board of County Commissioners (Communications), Deschutes County 911, incorporated cities & fire districts <u>External:</u> OEM, DOGAMI, USGS	Short Term	NEW	X	X	X	X	X
Flood #1		Continue to coordinate mitigation activities with appropriate agencies and home and business owners/groups that include an inventory of actions to or within the floodplain.	Deschutes County Community Development	<u>Internal:</u> Emergency Services, Public Works, Building Division <u>External:</u> Oregon Water Resources, DLCD, USGS, Bureau of Reclamation, DSL, USACE, ODFW, USFS	Ongoing	Ongoing	X	X	X		X
FL #2		Maintain an inventory of all permitted in-water facilities in Deschutes County.	Deschutes County Community Development	<u>Internal:</u> Emergency Services <u>External:</u> Oregon Water Resources, USGS, Bureau of Reclamation	Long Term	Deferred	X	X			
FL #3		Comply with National Flood Insurance Program to maintain participation in program.	Deschutes County Community Development	<u>Internal:</u> - <u>External:</u> DLCD, FEMA	Ongoing	Ongoing	X	X	X		X
FL #4		Update the Flood Insurance Rate Maps for Deschutes County and revisit land use codes to determine if floodplain standards are still adequate.	Deschutes County Community Development	<u>Internal:</u> - <u>External:</u> FEMA, DOGAMI, DLCD	Long Term	Ongoing	X	X	X		X
FL #5		As funding becomes available, upgrade individual properties adjacent to or within the floodplain as appropriate.	Deschutes County Community Development	<u>Internal:</u> - <u>External:</u> FEMA, DOGAMI, DLCD	Long Term	Ongoing	X	X	X		X
FL #6		Analyze and implement mitigation measures related to ice jamming that occurs during winter storm events.	Deschutes County Emergency Services/ Planning	<u>Internal:</u> Public Works, Bend Parks and Recreation District <u>External:</u> Oregon Water Resources, Pacific Power, Landowners, DLCD, DOGAMI	Long Term	Deferred	X	X			
FL #7		Re-evaluate debris flow and flood hazards along Whychus Creek from moraine-dammed Carver Lake. Depending on outcome of USAGE and USGS study, consider suitable mitigative measures in City of Sisters and Deschutes County.	Deschutes County Emergency Services	<u>Internal:</u> Community Development, Public Works; Sisters Community Development and Public Works <u>External:</u> USGS, USACE, FEMA, DOGAMI, OEM, DLCD, OSU Cascades	Long Term	Ongoing	X				X

Source: Deschutes County NHMP Steering Committee, updated 2021

Table 3-1 Deschutes County Action Items (Continued)

Source: Deschutes County NHMP Steering Committee, updated 2021

2021 Action Item	Priority	Proposed Action Title	Lead Agency	Partner Organization(s)	Timeline	Status	Jurisdictions				
							Deschutes County	Bend	La Pine	Redmond	Sisters
Landslide	No action items are identified specific to this hazard. However, several multi-hazard action items address this hazard.										
Volcano #1		Continue to support on-going study of probability of volcanic eruption and potential impact.	Deschutes County Emergency Services	<u>Internal:</u> Health Department, Community Development, Public Works <u>External:</u> USGS-CVO, DOGAMI, FEMA, OEM, USGS, OSU Cascades	Long Term	Deferred	X				
Wildfire #1	X	Expand public information/education initiatives in support of active hazardous fuels treatment.	Deschutes County Forester/ Project Wildfire	<u>Internal:</u> Emergency Services, County Forester <u>External:</u> Firewise Communities, USFS, BLM, ODF, DEQ	Ongoing	Ongoing	X	X	X	X	X
WF #2	X	Review and upgrade existing building and land use codes to address landscape, fuel amounts and structure detail that reduces the incidence or spread of wildland fire in urban/rural interface areas.	Deschutes County Community Development and County Forester	<u>Internal:</u> Community Development, County Forester, Emergency Services, Project Wildfire <u>External:</u> ODF	Ongoing	Ongoing	X	X	X	X	X
WF #3	X	Continue to prioritize and support fuels reduction projects on private lands utilizing FireFree and other programs; and identify and prioritize fuels reduction projects on public lands in the Wildland Urban Interface (WUI).	Project Wildfire	<u>Internal:</u> Community Development, County Forester, Emergency Services, Project Wildfire <u>External:</u> Firewise Communities, ODF	Ongoing	Ongoing	X	X	X	X	X
WF #4	X	Assess critical infrastructure resilience to wildfire	Deschutes County	<u>Internal:</u> Cities of Sisters, Bend, La Pine <u>External:</u> State OEM/State DLCDC	Medium Term	NEW	X	X	X		X
Winter Storm #1		Continue to coordinate mitigation activities to reduce risk to the public from severe winter storms.	Deschutes County Emergency Services	<u>Internal:</u> City and County Public Works, Public Health <u>External:</u> National Weather Service, Utility companies, Vulnerable Populations Work Group, American Red Cross, other Community Organizations Active in Disasters,	Ongoing	Ongoing	X	X	X	X	X

Table 3-1 Deschutes County Action Items (Continued)

2021 Action Item	Priority	Proposed Action Title	Lead Agency	Partner Organization(s)	Timeline	Status	Jurisdictions				
							Deschutes County	Bend	La Pine	Redmond	Sisters
WS #2		Continue public awareness of severe winter storm mitigation activities.	Deschutes County Emergency Services	<u>Internal:</u> City and County Public Works, Public Health <u>External:</u> National Weather Service, Vulnerable Populations Work Group, American Red Cross	Ongoing	Ongoing	X	X	X	X	X
WS #3		Continue to enhance coordination maintenance and mitigation activities to reduce risk to public infrastructure from severe winter storms.	Deschutes County Emergency Services	<u>Internal:</u> City and County Public Works, Public Health <u>External:</u> National Weather Service, Utilities, Vulnerable Populations Work Group, American Red Cross	Ongoing	Ongoing	X	X	X	X	X

Source: Deschutes County NHMP Steering Committee, updated 2021

SECTION 4:

PLAN IMPLEMENTATION AND MAINTENANCE

The Plan Implementation and Maintenance section details the formal process that will ensure that the MNHMP remains an active and relevant document. The Plan implementation and maintenance process includes a schedule for monitoring and evaluating the Plan semi-annually, as well as 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 Deschutes County NHMP depends on how well the outlined action items are implemented. In an effort to ensure that the activities identified are implemented, the following steps will be taken. The Plan will be formally adopted, a coordinating body will be assigned, a convener shall be designated, the identified activities will be prioritized and evaluated, and finally, the Plan will be implemented through existing plans, programs, and policies.

Plan Adoption

The Deschutes County NHMP was developed and will be implemented through a collaborative process. After the Plan is locally reviewed and deemed complete, the Deschutes County Emergency Services Manager submits it to the State Hazard Mitigation Officer (SHMO) at the Oregon Military Department – Office of Emergency Management (OEM). OEM submits the plan to FEMA-Region X for review. This review addresses the federal criteria outlined in the FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the County will adopt the plan via resolution. At that point the County will gain eligibility for the Building Resilient Infrastructure and Communities Grant Program funds, the Hazard Mitigation Grant Program funds, and Flood Mitigation Assistance program funds. Following adoption by the county, the participating jurisdictions should convene local decision makers and adopt the Deschutes County Multijurisdictional NHMP.

Convener

The Deschutes County Emergency Services Manager will take responsibility for plan implementation and will facilitate the Hazard Mitigation Coordinating Body meetings and will assign tasks such as updating and presenting the Plan to the rest of the members of the Coordinating Body. Plan implementation and evaluation will be a shared responsibility among all of the assigned Hazard Coordinating Body Members. The Convener's responsibilities include:

- Coordinate Steering Committee meeting dates, times, locations, agendas, and member notification;
- Documenting the discussions and outcomes of committee meetings;
- Serving as a communication conduit between the Steering Committee and the public/stakeholders;

- Identifying emergency management-related funding sources for natural hazard mitigation projects; and
- Utilizing the Risk Assessment as a tool for prioritizing proposed natural hazard risk reduction projects.

Coordinating Body

The Deschutes County Convener will form a Natural Hazard Coordinating Body for updating and implementing the NHMP. The Coordinating Body responsibilities include:

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

Members

The following jurisdictions, agencies, and/ or organizations were represented and served on the Steering Committee during the development of the Deschutes County NHMP (for a list of individuals see the Acknowledgements section of this NHMP):

- Deschutes County
- City of Bend
- City of La Pine
- City of Redmond
- City of Sisters
- Oregon Department of Forestry
- OSU Extension
- Oregon Water Resources Department
- Sisters-Camp Sherman Fire
- Black Butte Ranch Fire
- Bend Fire & Rescue
- Sunriver Fire
- City of Redmond Police Department
- Crooked River Ranch
- National Weather Service – Pendleton

To make the coordination and review of the Deschutes County NHMP as broad and useful as possible, the Coordinating Body will engage additional stakeholders and other relevant hazard mitigation organizations and agencies to implement the identified action items. Specific organizations have been identified as either internal or external partners on the individual action item forms found 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, FEMA requires the identification of existing programs that might be used to implement these action items. Deschutes County, and the participating cities, currently addresses statewide planning goals and legislative requirements through their comprehensive land use plans, capital improvement plans, mandated standards and building codes. To the extent possible, Deschutes County, and participating cities, will work to incorporate the recommended mitigation action items into existing programs and procedures.

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

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

- City and County Budgets
- Community Wildfire Protection Plans
- Comprehensive Land Use Plans
- Economic Development Action Plans
- Zoning Ordinances & Building Codes

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

Plan Maintenance

Plan maintenance is a critical component of the NHMP. Proper maintenance of the Plan ensures that this Plan will maximize the county and participating city's efforts to reduce the risks posed by natural hazards. This section was developed by Oregon Partnership for Disaster Resilience (OPDR) and was later adapted by Central Oregon Intergovernmental Council for purposes of the 2021 update. The maintenance plan includes a process to ensure that a regular review and update of the Plan occurs. The coordinating body and local staff are responsible for implementing this process, in addition to maintaining and updating the Plan through a series of meetings outlined in the maintenance schedule below.

Meetings

The Coordinating Body will meet on a **semi-annual basis** (twice per year) to complete the following tasks. The first meeting will take place in the spring, prior to the wildfire/ irrigation season. The meeting will include the County Coordinating Body, as well as the Steering Committee for the City of Bend and the City of La Pine. The second meeting of the year will take

place in early fall, following the wildfire/ irrigation season. The meeting will include the County Coordinating Body, as well as the Steering Committee for the City of Redmond and the City of Sisters.

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

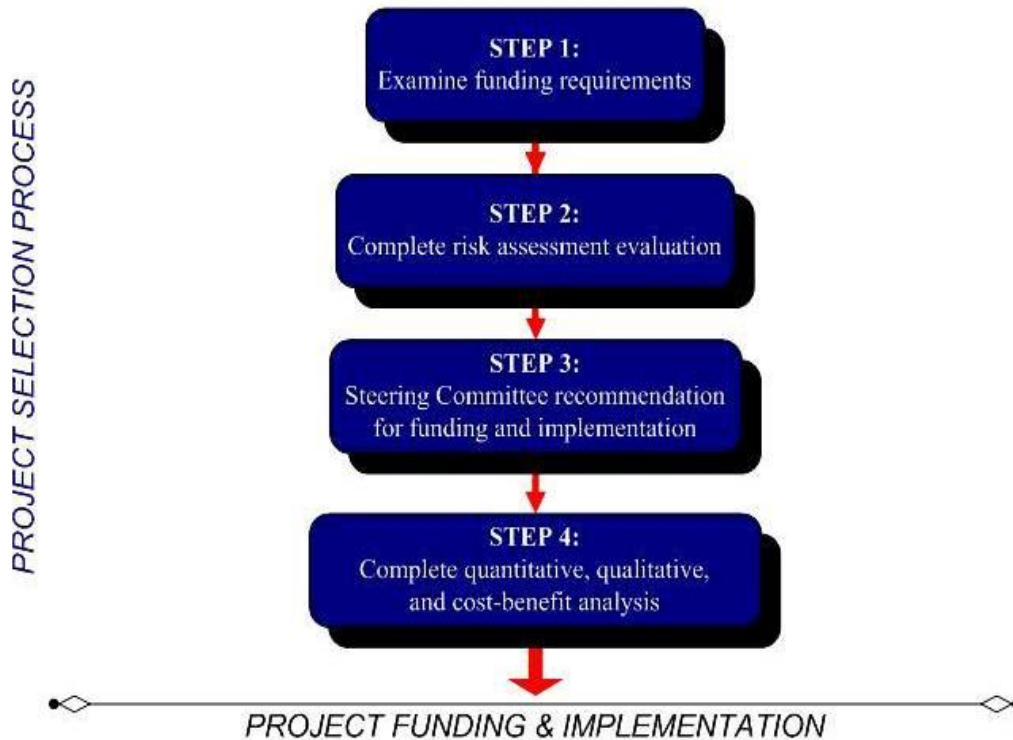
These meetings are an opportunity for the cities to report back to the county on progress that has been made towards their components of the NHMP.

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

Project Prioritization Process

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

Figure 4-1 Action Item and Project Review Process



Source: Oregon Partnership for Disaster Resilience, 2008

Step I: 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 Military Department – Office 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.

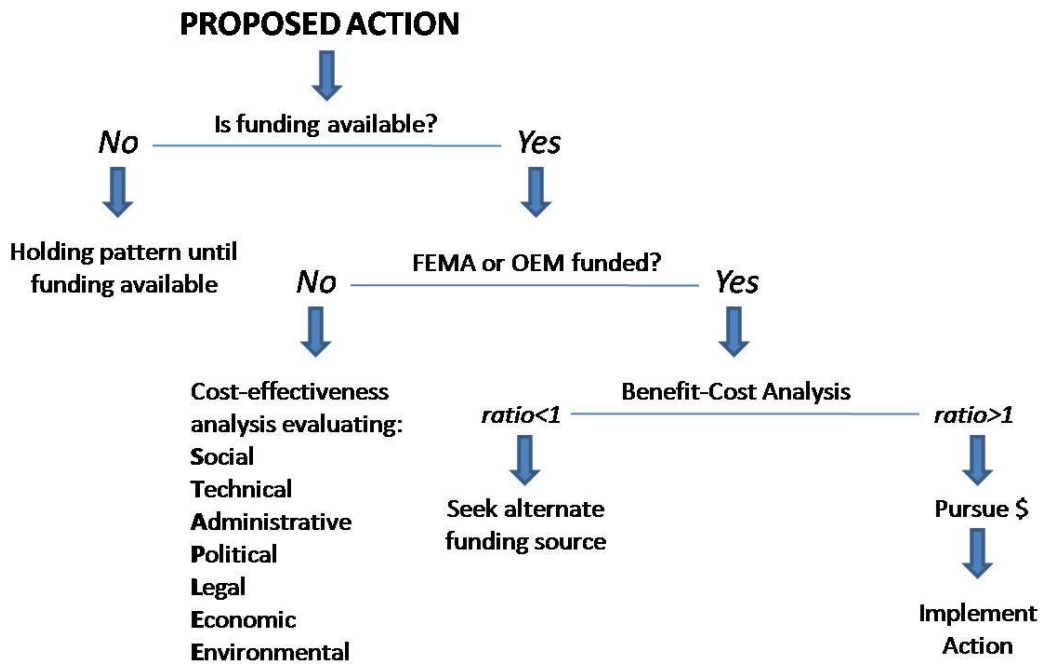
Step 3: Coordinating Body Recommendation

Based on the steps above, the Coordinating Body will recommend which mitigation activities should be moved forward. If the Coordinating Body decides to move forward with an action, the coordinating organization designated on the action item form will be responsible for taking further action and, if applicable, documenting success upon project completion. The Coordinating Body will convene a meeting to review 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 4-2 Benefit Cost Decision Criteria



Source: Oregon Partnership for Disaster Resilience, 2010

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

For non-federally funded or nonstructural projects, a qualitative assessment will be completed to determine the project’s cost effectiveness. The Coordinating Body will use a multivariable assessment technique called STAPLE/E to prioritize these actions. STAPLE/E stands for Social, Technical, Administrative, Political, Legal, Economic, and Environmental. Assessing projects based upon these seven variables can help define a project’s qualitative cost effectiveness. 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 Deschutes County NHMP. Although members of the Coordinating Body represent the public to some extent, the public will also have the opportunity to continue to provide feedback about the Plan.

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

- Post copies of their plans on corresponding websites;
- Place articles in the local newspaper directing the public where to view and provide feedback; and

- Use existing newsletters such as schools, utility bills, and social media outlets to inform the public where to view and provide feedback.

In addition to the involvement activities listed above, Deschutes County will ensure continued public involvement by posting the Deschutes County NHMP on the County's website (<http://www.deschutes.org/>). The Plan will also be posted on Central Oregon Intergovernmental Council's website (<https://www.coic.org/emergency-preparedness/natural-hazard-mitigation-plans/deschutes-county-nhmp/>).

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 Deschutes County NHMP is due to be updated by [INSERT DATE].** The Convener will be responsible for organizing the coordinating body to address plan update needs. The Coordinating Body will be responsible for updating any deficiencies found in the Plan, and for ultimately meeting the Disaster Mitigation Act of 2000's Plan update requirements.

The 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, 2021

VOLUME II: HAZARD ANNEXES

Significant Changes since the 2015 Plan

Significant changes to this section include: Maps and data were updated with the most recent information; the section about the Surface Water Supply Index was removed; and information was added to the section on Future Climate Variability.

Causes and Characteristics of the Hazard

Drought can be defined in several ways. The American Heritage Dictionary defines drought as "a long period with no rain, especially during a planting season." Oregon's Legislative Assembly describes drought as a potential state emergency when a lack of water resources threatens the availability of essential services and jeopardizes the peace, health, safety, and welfare of the people of Oregon.¹ Droughts can be characterized by the dominant impact caused by increased demand or decreased supply. Another definition of drought is a deficiency in surface and subsurface water supplies. In socioeconomic terms, drought is present when a physical water shortage begins to affect people, individually and collectively, and the area's economy.

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. The Oregon Drought Severity Index is the most commonly used drought measurement in the state because it incorporates both local conditions and mountain snowpack. The Oregon Drought Severity Index categorizes droughts as mild, moderate, severe, and extreme.

When droughts occur they can be problematic, impacting community water supplies, wildlife refuges, fisheries, and recreation. It is reasonable to assume that there is a high probability that Deschutes County will experience drought in the near future.²

Precipitation in Oregon follows a distinct spatial and temporal pattern; it tends to fall mostly in the cool season (October–March). The Cascade Mountains block rain-producing weather patterns, creating a very arid and dry environment east of these mountains. Moist air masses originating from the Pacific Ocean cool and condense when they encounter the mountain range, depositing precipitation primarily on the inland valleys and coastal areas.³

Water-related challenges are greater than just the temporal and spatial distribution of precipitation in Oregon. A rapidly growing population in the American West has placed a greater demand on this renewable, yet finite resource. The two terms, drought and water scarcity, are not necessarily synonymous; distinctly, water scarcity implies that demand is exceeding the supply. The combined effects of drought and water scarcity are far-reaching and merit special consideration.⁴

¹ Oregon Revised Statute §539.710

² State of Oregon NHMP, Region 6. 2020.

³ Ibid.

⁴ Ibid.

Drought is typically measured in terms of water availability in a defined geographic 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 does not provide a very accurate indication of drought conditions in Deschutes County, although it can be very useful because of its long-term historical record of wet and dry conditions.⁵

With climate change, snow droughts—the type of drought in which snowpack is low, but precipitation is near normal—are expected to occur more often. The 2015 drought in Deschutes County was a “snow drought” and serves as a good example of what future climate projections indicate may become commonplace by mid-21st century.⁶ Going forward, drought indices that can account for a changing climate, such as the Standard Precipitation-Evapotranspiration Index (SPEI), may provide a more accurate estimate of future drought risks.

Meteorological or Climatological Droughts

Meteorological droughts are defined in terms of the departure from a normal precipitation pattern and the duration of the event. These droughts are a slow-onset phenomenon that can take at least three months to develop and may last for several seasons or years.

Agricultural Droughts

Agricultural droughts link the various characteristics of meteorological drought to agricultural impacts. The focus is on precipitation shortages and soil-water deficits. Agricultural drought is largely the result of a deficit of soil moisture. A plant's demand for water is dependent on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil.

Hydrological Droughts

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

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. The Oregon Drought Severity Index is the most commonly used drought measurement in the state because it incorporates local conditions and mountain snowpack. The Oregon Drought Severity Index categorizes droughts as *mild*, *moderate*, *severe*, and *extreme*.

History of Drought in Deschutes County

Oregon records dating back to the late 1800s, clearly associate drought with a departure from expected rainfall. Concern for mountain snowpack, which feeds the streams and rivers, came

⁵ Ibid.

⁶ The Third Oregon Climate Assessment Report. 2017. https://pnwcirc.org/sites/pnwcirc.org/files/ocar3_finalweb.pdf

later. When droughts occur they can be problematic, impacting community water supplies, wildlife refuges, fisheries, and recreation. It is reasonable to assume that there is a high probability that Deschutes County will experience drought in the near future.

The following table is, in relevant part, from the State of Oregon 2020 NHMP. Deschutes County is in Region 6; drought declarations not impacting Deschutes have been omitted. It is not clear from the available information if all Region 6 droughts included a drought declaration in Deschutes County:

Table II-I History of Droughts

Date	Location	Characteristics
1928-1941	Statewide	A significant drought affected all of Oregon from 1928 to 1941. The prolonged statewide drought created significant problems for the agricultural industry. Punctuated by a three-year intense drought period from 1938-1941.
1985-1994	Statewide	A dry period lasting from 1985 to 1994 caused significant problems statewide. The peak year was 1992, when the state declared a drought emergency; 10 consecutive years of dry conditions caused problems throughout the state, such as fires and insect outbreaks.
2001-2002	Affected all Regions except 2&3	drought declaration (2001); 23 counties state-declared drought (2002); some of the 2001 and 2002 drought declarations were in effect through June or December 2003.
2005	Regions 5-7	Affected 13 of Oregon's 36 counties
2010	Region 6	Governor declared drought for Klamath and contiguous counties.
2015	Statewide	Governor-declared drought in 25 counties, with federal declarations in all counties. Oregon experienced its warmest year on record (1895–2019) resulting in record low snowpack across the state. All of Oregon was in severe or extreme drought at the peak of the drought in August, according to the U.S. Drought Monitor.
2018	Regions 4-8, 1	Governor declared drought in 11 counties
2020	Southern, Eastern Oregon	Deschutes, Jefferson, Crook, Klamath, Lake and other counties declared drought.

Sources: Oregon State Natural Hazard Mitigation Plan 2020; George and Ray Hatton, *The Oregon Weather Book* (1999); Oregon Secretary of State’s Archives Division (Governor’s Executive Orders); NOAA’s Climate at a Glance; Western Regional Climate Center’s Westwide Drought Tracker <http://www.wrcc.dri.edu/wwdt>; personal communication, Kathie Dello, Oregon Climate Service, Oregon State University.

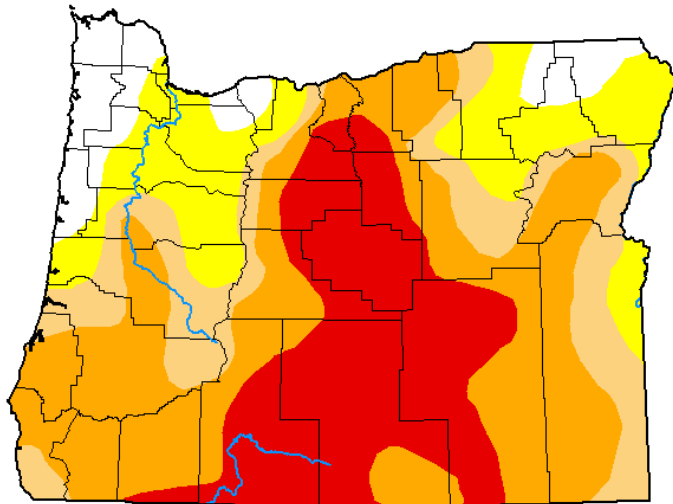
The figure below shows the county’s current drought conditions monitored according to the National Drought Mitigation Center at the University of Nebraska, Lincoln. The measurement shown displays the percent area of drought severity conditions. It indicates that the majority of Deschutes County is currently registering D2 Severe drought. The possible impacts of a severe drought are: likely crop or pasture losses, water shortages, and imposed water restrictions.⁷

⁷ USDM “U.S. Drought Monitor Classification Scheme”

Figure II-I U.S. Drought Monitor – Oregon

U.S. Drought Monitor
Oregon

January 26, 2021
(Released Thursday, Jan. 28, 2021)
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	7.72	92.28	75.90	59.80	25.52	0.00
Last Week 01-19-2021	8.48	91.52	75.08	60.36	26.81	0.00
3 Months Ago 10-27-2020	6.89	93.11	86.44	70.73	39.05	0.00
Start of Calendar Year 12-29-2020	8.57	91.43	83.53	68.71	27.74	0.00
Start of Water Year 09-29-2020	6.50	93.50	84.77	65.53	33.59	0.00
One Year Ago 01-28-2020	9.12	90.88	26.18	0.00	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Richard Tinker
CPC/NOAA/NWS/NCEP



droughtmonitor.unl.edu

Source: National Drought Mitigation Center, University of Nebraska, Lincoln. Droughtmonitor.unl.edu, Accessed February 2, 2021.

Hazard Identification

Deschutes County frequently experiences drought conditions, however, due to water availability the cities of Bend, La Pine, Redmond, and Sisters are rarely affected. At the time the plan was developed, no data existed to assist in identifying the location or extent of the drought hazard in Deschutes County. Typically, droughts occur as regional events and often affect more than one county. In severe droughts, environmental and economic consequences can be significant. In recent years, the State has addressed drought emergencies through the Oregon Drought Council. This interagency (state/federal) council meets to discuss climate outlooks, water and soil conditions, and advise the Governor as the need arises.

Droughts are not just a summer-time phenomenon; winter droughts can have a profound impact on the state’s agricultural sector, particularly east of the Cascade Mountains. Below-average snowfall in Oregon’s higher elevations has a far-reaching effect, especially in terms of irrigation and recreation. There also are environmental consequences. A prolonged drought in

Oregon's forests promotes an increase of insect pests, which in turn, damage trees already weakened by a lack of water. A moisture-deficient forest constitutes a significant fire hazard.

Probability Assessment

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. It is a temporary condition and differs from aridity because the latter is restricted to low rainfall regions and is a permanent feature of climate. It is rare for drought not to occur somewhere in North America each year. Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change, and the absence of historic information. 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. Deschutes County's Natural Hazards Mitigation Steering Committee believes that the County's **probability of experiencing a drought is "high,"** meaning one incident is likely within the next 10 – 35 year period. Oregon has yet to undertake a statewide comprehensive risk analysis for drought, to determine probability or vulnerability for a given community. However, based upon available information the Oregon NHMPs Regional Risk Assessment supports this probability rating for Deschutes County.⁸

Vulnerability Assessment

Rural areas are much more dependent on water for irrigation for agricultural production. Landowners in rural or less-populated areas are often reliant on individual, privately owned wells as a drinking water source. Generally speaking, counties east of the Cascades are more prone to drought-related impacts. Deschutes County is less vulnerable to drought impacts than other counties in the Region because its water source is a large aquifer system in the High Cascades which stores precipitation regardless of whether it is rain or snow. However, droughts can still be problematic. Potential impacts to community water supplies are the greatest threat. The aquifer is affected by long-term drought periods (consecutive years) . These extended periods of drought can impact forest conditions and set the stage for potentially destructive wildfires. Additional impacts are described in the Community Hazard Issues section. The Deschutes County Natural Hazards Steering Committee rated Deschutes County as having a **"low" vulnerability to drought hazards,** meaning less than 1% of the region's population or assets would be affected by a major emergency or disaster. Oregon has yet to undertake a statewide comprehensive risk analysis for drought, to determine probability or vulnerability for a given community. However, based upon available information the Oregon NHMPs Regional Risk Assessment rates Deschutes County's vulnerability to drought as high.⁹

Risk Analysis

The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section), and (2) the likelihood or probability of the harm occurring. Table 2-6 of the Risk Assessment (Volume I) shows the county's Hazard Analysis Matrix which scores each hazard

⁸ 2020 Oregon Natural Hazard Mitigation Plan. Department of Land Conservation and Development, 2021.

⁹ Ibid.

and provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard. Based on the matrix the **drought hazard is rated #4, out of 9 rated hazards, with a total score of 175.**

Future Climate Variability

One of the main aspects of the probability of future occurrences is its reliance on historic climate trends in order to predict future climate trends. Many counties in eastern Oregon are experiencing more frequent and severe droughts than is historically the norm, and many climate predictions see this trend continuing into the future. Temperatures in the Pacific Northwest region increased in the 20th Century by about 2.2 degrees Fahrenheit and are projected to increasingly rise by an average of 5°F by the 2050s and 8.2°F by the 2080s, with the greatest seasonal increases in summer.¹⁰ Precipitation in Oregon is expected to increase in winter and decrease in summer.¹¹ The predicted increase in winter temperatures will reduce snowpack, which in turn will have effects on spring runoff. In this scenario, the mainstream of the Upper Deschutes River would remain more resilient compared to some of its dominantly snow-fed tributaries such as the Little Deschutes River, Whychus Creek and to a lesser extent Tumalo Creek.¹² These tributaries may respond to the projected climate changes similarly to other Oregon rivers.

With climate change, snow droughts—the type of drought in which snowpack is low, but precipitation is near normal—are expected to occur more often. The 2015 drought in Deschutes County was a “snow drought” and serves as a good example of what future climate projections indicate may become commonplace by mid-21st century.¹³ Going forward, drought indices that can account for a changing climate, such as the Standard Precipitation-Evapotranspiration Index (SPEI), may provide a more accurate estimate of future drought risks.

Community Hazard Issues

Drought is frequently an "incremental" hazard, meaning both the onset and end are often difficult to determine. Also, its effects may accumulate slowly over a considerable period of time and may linger for years after the termination of the event.

Droughts are not just a summer-time phenomenon; winter droughts can have a profound impact on agriculture, particularly east of the Cascade Mountains. Also, below average snowfall in higher elevations has far-reaching effects, especially in terms of hydro-electric power, irrigation, recreational opportunities and a variety of industrial uses.

Drought can affect all segments of a jurisdiction’s population, particularly those employed in water-dependent activities (e.g., agriculture, hydroelectric generation, recreation, etc.). Also,

¹⁰ Dalton, M., and E. Fleishman, editors. 2021. Fifth Oregon Climate Assessment. Oregon Climate Change Research Institute, Oregon State University, Corvallis, Oregon. <https://blogs.oregonstate.edu/occri/oregon-climate-assessments/>

¹¹ Ibid.

¹² Gannett, M.W., and Lite, K.E., Jr., 2004, Simulation of regional ground-water flow in the upper Deschutes Basin, Oregon: U.S. Geological Survey Water-Resources Investigations Report 03–4195, 84 p.

¹³ Dalton, M.M., K.D. Dello, L. Hawkins, P.W. Mote, and D.E. Rupp. 2017. The third Oregon climate assessment report. Oregon Climate Change Research Institute, Oregon State University, Corvallis, Oregon. <https://blogs.oregonstate.edu/occri/oregon-climate-assessments/>

domestic water-users may be subject to stringent conservation measures (e.g., rationing) and could be faced with significant increases in electricity rates. In addition, water-borne transportation systems (e.g., ferries, barges, etc.) could be impacted by periods of low water.

There also are environmental consequences. A prolonged drought in forests promotes an increase of insect pests, which in turn, damage trees already weakened by a lack of water. A moisture-deficient forest constitutes a significant fire hazard (see the Wildfire summary). In addition, drought and water scarcity add another dimension of stress to species listed pursuant to the Endangered Species Act (ESA) of 1973.

More information on this hazard can be found in the [Regional Risk Assessment for Region 6 of the Oregon NHMP](#).

Existing Authorities, Policies, Programs, and Resources

Existing authorities, policies, programs, and resources include current mitigation programs and activities that are being implemented by city, county, regional, state or federal agencies and/or organizations.

County and Cities

Deschutes County currently addresses the drought hazard through water conservation measures and water monitoring.

State

Drought Council

The Drought Council is responsible for assessing the impact of drought conditions and making recommendations to the Governor's senior advisors. The Water Availability Committee, a subcommittee of technical people who monitor conditions throughout the state and report these conditions monthly, advises the Drought Council. In this manner the Drought Council keeps up-to-date on water conditions.

Federal

Natural Resources Conservation Service

The United States Department of Agriculture Natural Resources Conservation Service (NRCS) has a regional service center located in Redmond (another is located in Warm Springs). The NRCS is dedicated to three main priorities involving resource preservation. One among them is water quantity and quality. The NRCS incorporates a conservation implementation strategy to preserve natural resources into the future.¹⁴

¹⁴ NRCS – Deschutes County “Information for Partners and Participants,” <http://www.or.nrcs.usda.gov>

Hazard Mitigation Action Items

There are no identified Drought action items for Deschutes County; however, several of the Multi-Hazard action items affect the Drought hazard. An action item matrix is provided within Volume I, Section 3, while action item forms are provided within Volume IV, Appendix A. To view city actions see the appropriate city addendum within Volume III.

EARTHQUAKE

Significant Changes since the 2015 Plan

There are no significant changes in the potential for earthquakes to occur in Deschutes County since 2015, therefore, there are no significant changes in this section from the 2015 Plan. However, the format of the section and minor content changes has occurred.

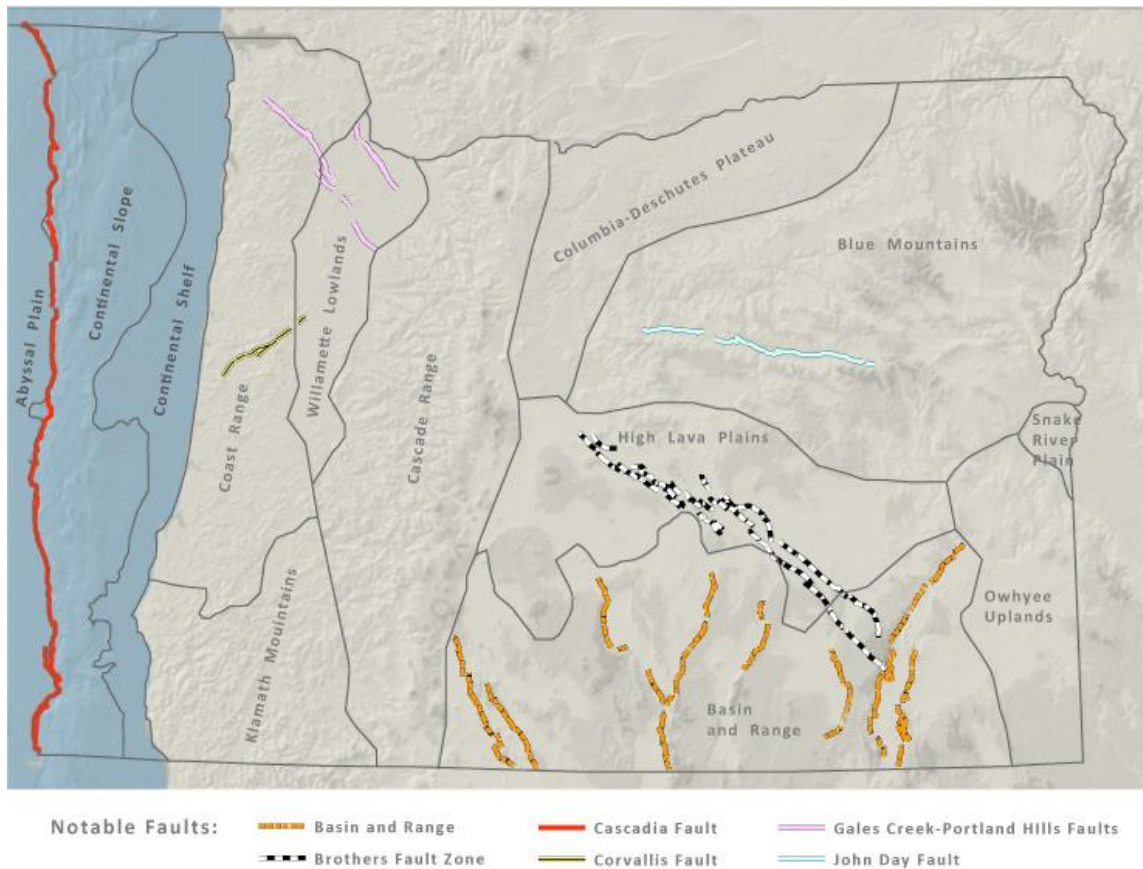
Causes and Characteristics of the Hazard

Seismic events were once thought to pose little or no threat to Oregon communities. However, recent earthquakes and scientific evidence indicate that the risk to people and property is much greater than previously thought. Oregon and the Pacific Northwest in general are 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.

Central Oregon includes portions of five physiographic provinces including the High Cascades, Blue Mountains, Basin and Range, High Lava Plains, and Deschutes-Columbia Plateau. Consequently, its geology and earthquake susceptibility varies considerably. There have been several significant historical earthquakes in the region; however all have been located in Klamath and Lake Counties. Additionally, geologically active faults are located in Deschutes, Klamath, and Lake Counties. 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 II-2 Oregon Fault Lines



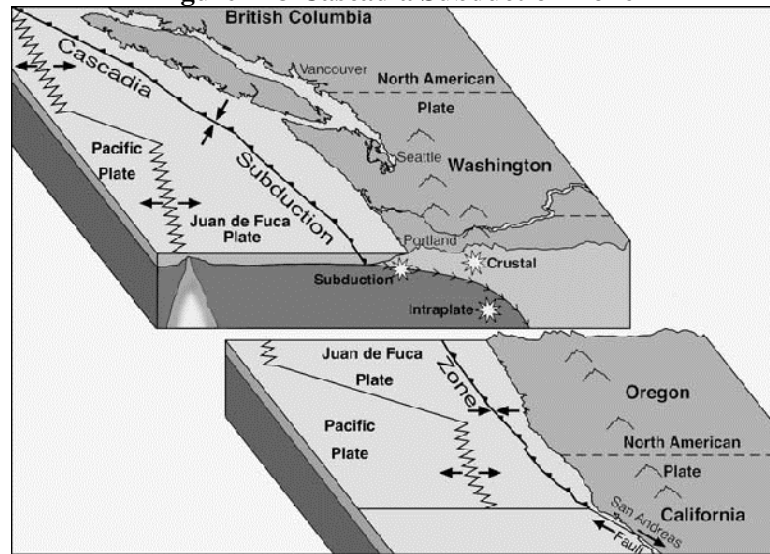
Source: Oregon Department of Geology and Mineral Industries. <https://www.oregongeology.org/pubs/ims/ims-028/faults.htm>. Accessed March 2021.

Subduction Zone Earthquakes

The Pacific Northwest is located at a convergent plate boundary, called the Cascadia Subduction Zone (CSZ, see Figure II-3), where the Juan de Fuca and North American tectonic plates meet. It extends from British Columbia to northern California. Earthquakes are caused by the abrupt release of slowly accumulated stress. The two plates are converging at a rate of about 1.5 inches per year¹.

¹Interagency Hazard Mitigation Team. 2020. Oregon Natural Hazards Mitigation Plan. Salem, OR: Oregon Military Department – Office of Emergency Management

Figure II-3 Cascadia Subduction Zone



Source: Shoreland Solutions. Chronic Coastal Natural Hazards Model Overlay Zone. Salem, OR: Oregon Department of Land Conservation and Development (1998) Technical Guide-3.

Although there have been no large historical earthquakes along the offshore Cascadia Subduction Zone, similar subduction zones worldwide produce large “megathrust” earthquakes with magnitudes of 8 or larger. They occur because the oceanic crust “sticks” as it is being pushed beneath the continent, rather than sliding smoothly. Over hundreds of years, large stresses build up, which are released suddenly in “megathrust” earthquakes. Such earthquakes typically have a minute or more of strong ground shaking, and are quickly followed by numerous large aftershocks.

Historic subduction zone earthquakes include the 1960 Chile earthquake (magnitude 9.5), the 1964 southern Alaska earthquake (magnitude 9.2), the 2004 Indian Ocean earthquake (magnitude 9.0) and the 2011 Tohoku earthquake (magnitude 9.0). Geologic evidence shows that the Cascadia Subduction Zone has generated great earthquakes of similar magnitude, most recently about 320 years ago.²

Deep Intraplate Earthquakes

Deep intraplate earthquakes occur at depths of 18 to 60 miles below the earth’s surface in the subducting oceanic crust and can reach magnitude 7.5.³ This type of earthquake is more common in the Puget Sound region; in Oregon these earthquakes occur at lower rates and none have occurred at damaging magnitudes.⁴ The February 28, 2001 Nisqually earthquake (magnitude 6.8) in Washington State was a deep intraplate earthquake. It produced a rolling

² Interagency Hazard Mitigation Team. 2020. Oregon Natural Hazards Mitigation Plan. Salem, OR: Oregon Military Department – Office of Emergency Management

³ Planning for Natural Hazards: Oregon Technical Resource Guide, Community Planning Workshop, (July 2000), p. 8-8.

⁴ Interagency Hazard Mitigation Team. 2020. Oregon Natural Hazards Mitigation Plan. Salem, OR: Oregon Military Department – Office of Emergency Management

motion that was felt from Vancouver, British Columbia to Coos Bay, Oregon and east to Salt Lake City, Utah.⁵

Shallow Crustal Earthquakes

These are the most common earthquakes and occur in the North American Plate at relatively shallow depths of 6-12 miles below the surface.⁶ When crustal faults slip, they can produce earthquakes of magnitudes up to 7.0. Although most crustal fault earthquakes are smaller than 4.0 and generally create little or no damage, some of them can cause extensive damage. The 1993 Klamath Falls earthquakes (magnitude 6.0 and 5.9) were crustal earthquakes.

Volcanic Earthquakes

Volcanic earthquakes are usually smaller than magnitude 2.5, roughly the threshold for shaking felt by observers close to the event. Swarms of small earthquakes may persist for weeks to months before eruptions, but little or no earthquake damage would occur to buildings in surrounding communities. Some volcanic related swarms may include earthquakes as large as about magnitude 5. For the communities of Bend, La Pine, and Sunriver, shallow earthquakes in the magnitude 4-5 range that are located beneath Newberry Volcano would cause walls to rattle or windows and dishes to vibrate. Both Newberry and the Three Sisters volcanoes routinely experience small magnitude earthquakes that are not felt.

While all four types of earthquakes have the potential to cause major damage, subduction zone earthquakes pose the greatest danger. A major CSZ event could generate an earthquake with a magnitude of 9.0 or greater resulting in devastating damage and loss of life. Such earthquakes may cause great damage to the coastal area of Oregon as well as inland areas in western Oregon; damage to Deschutes County will be less severe, however, it is expected that the impact of such an event will greatly affect eastern Oregon.

The specific hazards associated with earthquakes are explained below:

Ground Shaking

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. Ground shaking is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault that is slipping, distance from the epicenter (where the earthquake originates), and local geology. Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

“Due to the amount of faulting in the area, [the 1993 Klamath Falls earthquake] is just business as usual for such a geologically active region. Historic evidence, combined with geologic evidence for large numbers of earthquakes in the prehistoric past, suggest that one or more earthquakes capable of damage (magnitude 4 – 6) hit south-central Oregon every few decades, so it pays to be prepared.”

James Roddey, DOGAMI

⁵ Hill, Richard. “Geo Watch Warning Quake Shook Portland 40 Years Ago.” The Oregonian. October 30, 2002.

⁶ Madin, Ian P. and Zhenming Wang, Relative Earthquake Hazard Maps Report, DOGAMI, 1999.

Ground Shaking Amplification

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

Surface Faulting

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

Liquefaction and Subsidence

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

Earthquake-Induced Landslides and Rockfalls

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

History of Earthquakes in Deschutes County

A summary of significant earthquake events in the Deschutes County region is found in the table below.

Table II-2 Selected Earthquakes, M 5.0+ (1971-2014)

Date	Location	Magnitude	Comments
Approximate years: 1400 BCE, 1050, BCE 600 BCE 400, 750, 900	Offshore, Cascadia subduction zone	Probably 8.0-9.0	Based on studies of earthquakes and tsunamis in Willapa Bay, WA. These are the midpoints of the age ranges for these six events.
January 1700	Offshore, Cascadia Subduction zone	Approximately 9.0	Generated a tsunami that struck Oregon, Washington and Japan; destroyed Native American villages along the coast.
April 1906	North of Lakeview, OR	5.0	Three felt aftershocks.
April 1920	Crater Lake	5.0	
January 1923	Lakeview, OR	6.0	
March 1958	Southeast of Adel, OR	4.5	Damage unknown
1968	Adel	4.7-5.1	Damage to homes. 20 earthquakes of M4 or greater were recorded between 5/28/68 & 6/24/68.
September 20, 1993	Klamath County	5.9 and 6.0	Two deaths, \$10 million damage, including county courthouse; rockfalls induced by ground motion.

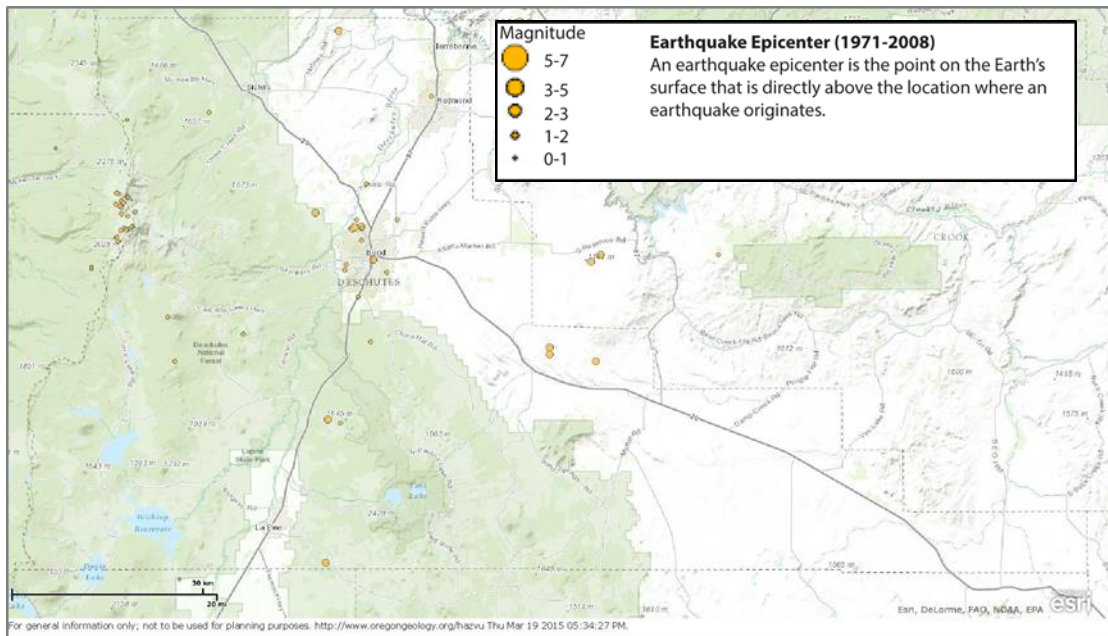
Source: Ivan Wong and others, "A Look Back at Oregon's Earthquake History, 1841-1994," in Oregon Geology, (1995), 125-139; Niewendrop and others, "Map of Selected Earthquakes for Oregon, 1841 through 2002," DOGAMI, (2003).

The Klamath County earthquakes on September 21, 1993, caused two deaths and approximately 7.5 million dollars in damage. One person was killed when a boulder crushed the car he was driving in an earthquake-induced rock fall, and another person died of a heart attack. More than 1,000 homes and commercial buildings were damaged.⁷

Deschutes County routinely has small earthquake events. The earthquakes shown in the figure below are relatively insignificant events below M 5.0. The larger events may have been slightly felt but little to no structural/property damage resulted. There is no historic record of significant crustal earthquakes centered in Deschutes County during the past 150 years, although Oregon has experienced crustal earthquakes that originated outside the county. Recent earthquake events in Deschutes County include a two-day swarm of 100 to 200 small, unfelt earthquakes in the Three Sisters region (shown below on the left side of the map) in April 2004. Additionally, a seismic network on Newberry Volcano has recorded numerous small, unfelt earthquakes since its installation in 2011.

⁷ USGS, Earthquake Hazards Program, [Earthquake Catalogue](#).

Figure II-4 Earthquake Epicenters (1971-2008)

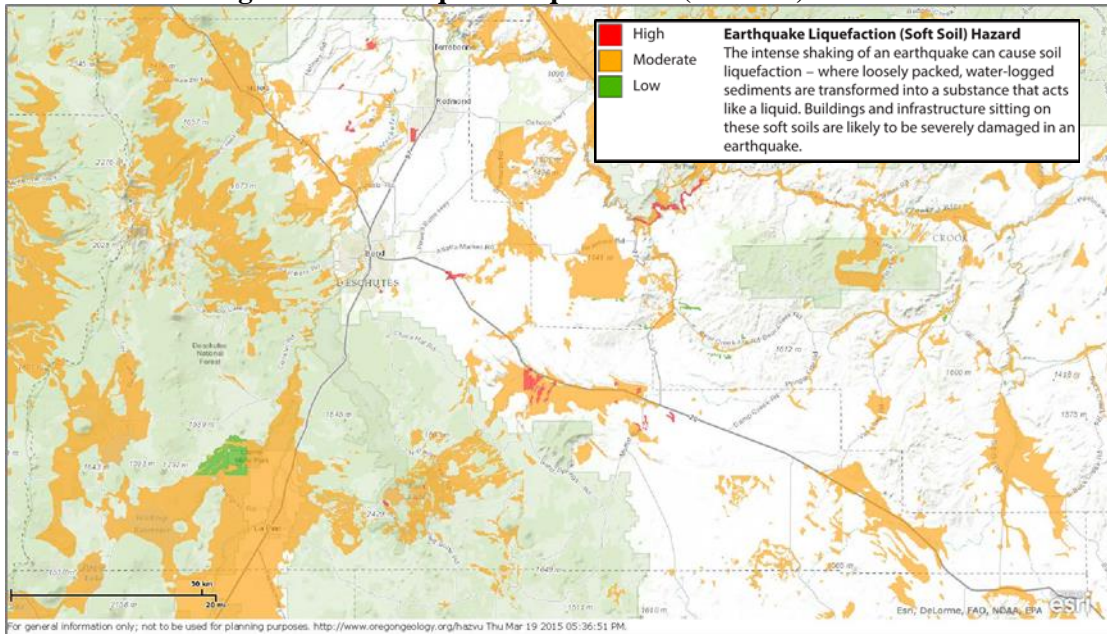


Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu), accessed April 2021.

Hazard Identification

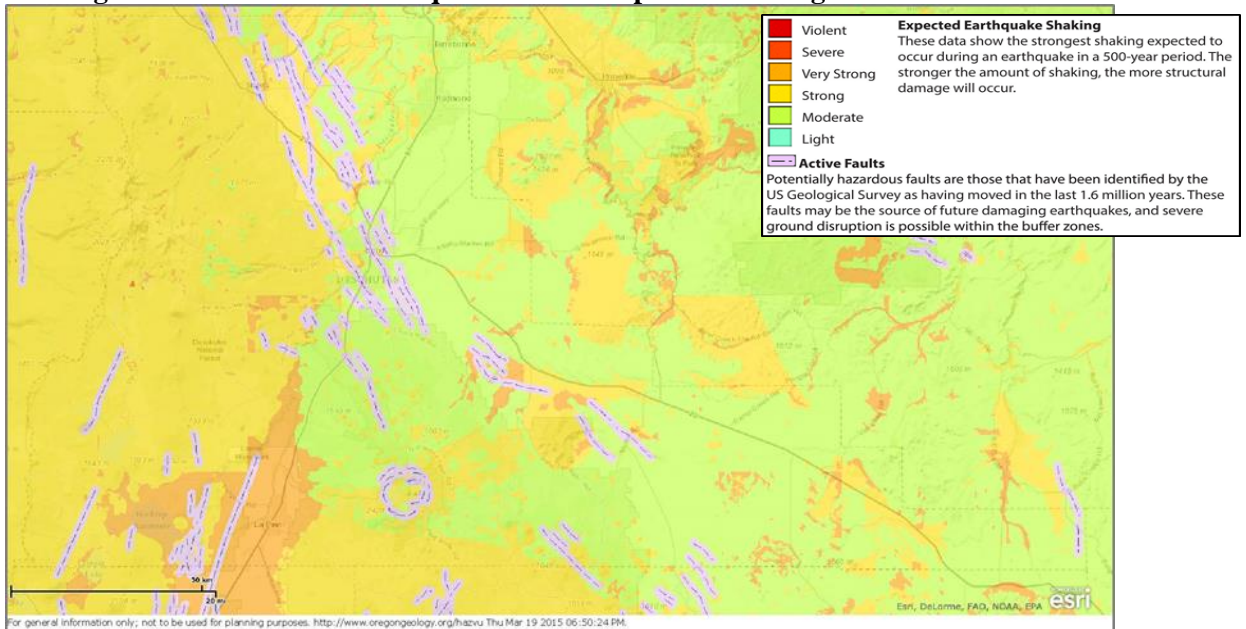
The Oregon Department of Geology and Mineral Industries (DOGAMI), in partnership with other state and federal agencies, has undertaken a rigorous program in Oregon to identify seismic hazards, including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides. DOGAMI has published a number of seismic hazard maps that are available for Oregon communities to use. The maps show liquefaction, ground motion amplification, landslide susceptibility, and relative earthquake hazards. Steering Committee members used the DOGAMI Statewide Geohazards Viewer to present visual maps of recent earthquake activity (Figure II-4), liquefaction (soft soils, Figure II-5), and expected ground shaking for combined earthquake events (Figure II-6; see vulnerability assessment for more information on the combined events). 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.

Figure II-5 Earthquake Liquefaction (Soft Soil) Hazard



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu), accessed March 2015

Figure II-6 Combined Earthquake Events Expected Shaking and Active Faults



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu), accessed April 2021

The maps indicate the predominant risks for the county lie in the southwestern portion of the county in the La Pine and Sunriver region; it also shows greater risk in the Sisters region.

Probability Assessment

The Cascadia Subduction Zone (CSZ) generates an earthquake on average every 250-500 years. However, as with any natural processes the average time between events can be misleading.

Some of the earthquakes may have been 150 years apart while some closer to 1,000 years apart.⁸ 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. Mitigation action calls for study of the probability of earthquake events specific to Deschutes County.

It is not feasible at this time to predict when central Oregon or Cascadia will have another moderate to large earthquake. The statistical uncertainty associated with calculating earthquake recurrence intervals are as large as or larger than the calculated recurrence interval. That being said, Deschutes County’s Natural Hazards Mitigation Steering Committee hypothesizes that the County’s **probability of experiencing a crustal earthquake is “low”**, meaning one incident is likely within the next 75 – 100 year period; the committee hypothesizes that the County’s **probability of experiencing a Cascadia earthquake is also “low”**. Based upon available information, the Oregon NHMPs Regional Risk Assessment rates Deschutes County’s probability of earthquake as moderate.⁹

Vulnerability Assessment

The Oregon Department of Geology and Mineral Industries (DOGAMI) has developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: 1) the CSZ, and 2) combined earthquake events. Both models are based on HAZUS, a computerized program, currently used by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes.

The CSZ event is based on a potential 8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from the event (but not affect Deschutes County). The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults, each with a 10% chance of producing an earthquake in the next 50 years. The model assumes that each fault will produce a single “average” earthquake during this time. Neither model takes unreinforced masonry building into consideration. DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning purposes. Despite their limitations, the models do provide some approximate estimates of damage. Further mention is made of potential for possible flooding in the event of an earthquake in the area of the South Sister uplift. Current research being conducted of this area will determine potential impact and flooding potential.

The Deschutes County Natural Hazards Steering Committee rated Deschutes County as having a **“moderate” vulnerability to the crustal earthquake hazard**, meaning 1-10% of the region’s population or assets would be affected by a major emergency or disaster; the committee rated the County as having a **“high” vulnerability to the Cascadia earthquake hazard**, meaning more than 10% of the region’s population or assets would be affected by a major emergency or disaster. The Oregon NHMPs Regional Risk Assessment rates Deschutes County’s vulnerability to earthquakes as very low.¹⁰

⁸ Y. Wang & J.L. Clark, Special Paper 29, Earthquake Damage in Oregon: Preliminary Estimates of Future Earthquake Losses. 1999. DOGAMI.

⁹ 2020 Oregon Natural Hazard Mitigation Plan. Department of Land Conservation and Development, 2021.

¹⁰ Ibid.

Risk Analysis

The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section), and (2) the likelihood or probability of the harm occurring. Table 2-6 of the Risk Assessment (Volume I, Section 2) shows the county's Hazard Analysis Matrix which scores each hazard and provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard. Based on the matrix the **Cascadia earthquake hazard is rated #6, out of 9 rated hazards, with a total score of 149; while the crustal earthquake hazard is rated #8, out of 9 rated hazards, with a total score of 109.**

Community Hazard Issues

The effects of earthquakes span a large area, and can cause secondary effects such as landslides, fires and flooding. The degree to which earthquakes are felt, however, and the damages associated with them may vary. At risk from earthquake damage are unreinforced masonry buildings, bridges built before earthquake standards were incorporated into building codes, sewer, water, and natural gas pipelines, petroleum pipelines, and other critical facilities and private property located within the county. The areas that are particularly vulnerable to potential earthquakes in the county have been identified as those with soft, alluvial sediments and lands along stream channels. Additionally, the Carver Lake dam has been identified as a hazard risk to the city of Sisters that can be triggered by an earthquake event. For more information on the Carver Lake dam risks, please see the Flood Annex.

Earthquake damage to roads and bridges can be particularly serious by hampering or cutting off the movement of people and goods and disrupting the provision of emergency response services. Such effects in turn can produce serious impacts on the local and regional economy by disconnecting people from work, home, food, school and needed commercial, medical and social services. A major earthquake can separate businesses and other employers from their employees, customers, and suppliers thereby further hurting the economy. Deschutes County is less susceptible to being isolated, unlike other areas of Oregon, due to its location along major highways, which run through multiple locations in the county. Finally, following an earthquake event, the cleanup of debris can be a huge challenge for the community.

Death and Injury

Death and injury can occur both inside and outside of buildings due to falling equipment, furniture, debris, and structural materials. Likewise, downed power lines or broken water and gas lines endanger human life. Death and injury are highest in the afternoon when damage occurs to commercial and residential buildings and during the evening hours in residential settings.¹¹

Disruption of Critical Facilities

Critical facilities are police stations, fire stations, hospitals, and shelters. These are facilities that provide services to the community and need to be functional after an earthquake event. The

¹¹ Planning for Natural Hazards: Oregon Technical Resource Guide, Community Planning Workshop (July 2000).

earthquake effects outlined above can all cause emergency response to be disrupted after a significant event.¹² Tables II-3 and II-4 (below) and tables in the city addenda, display damage and collapse potential for structures including critical and essential facilities.

Economic Loss

Seismic activity can cause great loss to businesses, either a large-scale corporation or a small retail shop. Losses not only result in rebuilding cost, but fragile inventory and equipment can be destroyed. When a company is forced to stop production for just a day, business loss can be tremendous. Residents, businesses, and industry all suffer temporary loss of income when their source of finances are damaged or disrupted.

The potential losses from an earthquake in Deschutes County extend beyond those to human life, homes, property and the landscape. A recent earthquake damage model has not been conducted for Deschutes County, however, based upon data from a 1999 DOGAMI report rough loss estimates are available. The economic base in Deschutes County is estimated at \$4,676,000,000 (in 1999 dollars); it is expected that the County will incur total direct losses valuing \$5,000,000 (in 1999 dollars) for the Cascadia model and \$71,000,000 (in 1999 dollars) for the 500-year model; both amount to a loss ratio of less than one-percent.¹³ While the expected losses have increased due to increased development in the County, as well as inflation, the loss ratio and relative damage for the county is expected to be similar. See table on the following page for more information on expected losses.

Local business economies are at substantial risk if an earthquake damages or otherwise necessitates the closure of any of the major transportation routes in Deschutes County. As such, the economic loss to the region can exceed \$3.5 million per day in the County.

¹² Y. Wang & J.L. Clark, Special Paper 29, Earthquake Damage in Oregon: Preliminary Estimates of Future Earthquake Losses. 1999. DOGAMI.

¹³ Ibid. The loss ratio is determined as a percentage of the expected losses to the county's economic base.

Table II-3 Deschutes County Earthquake Damage Summary

Deschutes County	8.5 Cascadia subduction zone event	500 year model
Injuries	1	17
Deaths	0	0
Displaced households	0	5
Short term shelter needs	0	3
Economic losses for buildings	\$5 million	\$71 million
Operating the day after the quake:		
Fire stations	100%	NA
Police stations	99%	NA
Schools	99%	NA
Bridges	100%	NA
Economic losses to:		
Highways	\$17,000	\$572,000
Airports	\$40,000	\$2 million
Communication systems:		
Economic losses	\$2,000	\$1 million
Operating the day of the quake	99%	NA
Debris generated (thousands of tons)	3	47

8.5 Cascadia event	Percentage of buildings in damage categories				
Building type	None	Slight	Moderate	Extensive	Complete
Agriculture	93	1	0	0	0
Commercial	93	1	0	0	0
Education	89	1	0	0	0
Government	98	1	0	0	0
Industrial	93	2	0	0	0
Residential	98	1	0	0	0

500 year model	Percentage of buildings in damage categories				
Building type	None	Slight	Moderate	Extensive	Complete
Agriculture	75	10	7	2	0
Commercial	72	11	9	3	0
Education	71	10	7	2	0
Government	75	12	9	3	1
Industrial	69	12	10	3	1
Residential	83	10	5	1	0

These figures have a high degree of uncertainty and should be used only for general planning purposes. Because of rounding, numbers may not add up to 100%.

Because the 500 year model includes several earthquakes, the number of facilities operational the "day after" cannot be calculated.

Source: Y. Wang & J.L. Clark, Special Paper 29, Earthquake Damage in Oregon: Preliminary Estimates of Future Earthquake Losses. 1999. DOGAMI.

Bridge Damage

All bridges can sustain damage during earthquakes, leaving them unsafe for use. More rarely, some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link – damage to them can make some areas inaccessible.

Because bridges vary in size, materials, siting, and design, earthquakes will affect each bridge differently. Bridges built before the mid 1970's often do not have proper seismic reinforcements. These bridges have a significantly higher risk of suffering structural damage during a moderate to large earthquake. Bridges built in the 1980's and after are more likely to have the structural components necessary to withstand a large earthquake.¹⁴

Damage to Lifelines

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

Fire

Fire is a common and significant hazard associated with earthquakes. Downed or arcing power lines and broken gas mains can trigger fires. Historically, these hazards, combined with damage to firefighting infrastructure like water systems and fire stations as a result of seismic activity, has resulted in significant loss of buildings and other infrastructure without sufficient preparedness and reinforcement of existing systems and resources.¹⁵

Debris

After damage occurs to a variety of structures, much time is spent cleaning up brick, glass, wood, steel or concrete building elements, office and home contents, and other materials. More

2001 Nisqually Earthquake

A 6.8 magnitude earthquake centered southwest of Seattle struck on February 28, 2001, followed by a mild aftershock the next morning, and caused more than \$1 billion worth of damage. Despite this significant loss, the region escaped with relatively little damage for two reasons: the depth of the quake center and preparations by its residents. Washington initiated a retrofitting program in 1990 to strengthen bridges, while regional building codes mandated new structures withstand certain amounts of movement. Likewise, historic buildings have been voluntarily retrofitted with earthquake-protection reinforcements.

Source: "Luck and planning reduced Seattle quake damage", CNN Report, March 1, 2001

¹⁴ University of Washington website: www.geophys.washington.edu/SEIS/PNSN/INFO_GENERAL/faq.html#3.

¹⁵ Pacific Northwest Seismic Network, *Earthquake Hazards*. <https://pnsn.org/outreach/earthquakehazards/fire>

information on this hazard can be found in the [Regional Risk Assessment for Region 6 of the Oregon NHMP](#).

Building and Home Damage

Wood structures tend to withstand earthquakes better than structures made of brick or unreinforced masonry buildings.¹⁶ Building construction and design play a vital role in the survival of a structure during earthquakes. Damage can be quite severe if structures are not designed with seismic reinforcements or if structures are located atop soils that liquefy or amplify shaking. Whole buildings can collapse or be displaced. For an approximation of buildings at risk of collapse by year built see Appendix C.

In 2007, DOGAMI completed a rapid visual screening (RVS) of educational and emergency facilities in communities across Oregon, as directed by the Oregon Legislature in Senate Bill 2 (2005). RVS is a technique used by the Federal Emergency Management Agency (FEMA), known as FEMA 154, to identify, inventory, and rank buildings that are potentially vulnerable to seismic events. DOGAMI surveyed 78 facilities in Deschutes County; of these seven are within county jurisdiction (see City addenda for facilities within city jurisdiction).

DOGAMI scored each building with a 'low,' 'moderate,' 'high,' or 'very high' potential of collapse in the event of an earthquake. It is important to note that these rankings represent a probability of collapse based on limited observed and analytical data and are, therefore approximate rankings.¹⁷ To fully assess a building's potential of collapse, a more detailed engineering study completed by a qualified professional is required, but the RVS study can help to prioritize which buildings to retrofit.

The table below displays the rankings of all facilities within the county's jurisdiction; each "X" represents one building within that ranking category. Of the buildings evaluated by DOGAMI using RVS, none have very high (100% chance) collapse potential, and two buildings have high (greater than 10% chance) collapse potential. The buildings with 'high' or 'very high' collapse potential include multiple public safety and education facilities located throughout the county all of which can play a key role in during disasters events or during long-term recovery. Please see the city addenda for a list of facilities within each jurisdiction (note: some county facilities are located within city jurisdiction, as such they are represented in the applicable addendum table).

It is important to note that the rapid visual survey scores have not been updated since 2007. Therefore, some building changes (movement of facilities and/or new buildings built) have occurred. However, all new buildings can be assumed to be at "low" collapse risk, given updated building codes.

¹⁶ Wolfe, Myer, et al. Land Use Planning for Earthquake Hazard Mitigation: A Handbook for Planners, Special Publication 14, Natural Hazards Research and Applications Information Center.

¹⁷ State of Oregon Department of Geologic and Mineral Industries, "Implementation of 2005 Senate Bill 2 Relating to Public Safety, Seismic Safety and Seismic Rehabilitation of Public Building", May 22, 2007, Open File Report 0-07-02.

Table II-4 Rapid Visual Survey Scores

Facility	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Schools				
Three Rivers Elementary School (56900 Enterprise Dr, Sunriver)	X			
Terrebonne Community School (1199 B Ave, Terrebonne)	X		X	
Public Safety				
Cloverdale RFPD (68787 George Cyrus Rd, Cloverdale)	X		X	
Cloverdale RFPD (67433 Cloverdale Rd, Cloverdale)		X		
Sunriver Police Department (57455 Abbot Dr, Sunriver)	X			
Sunriver Fire Department (57475 Abbot Dr, Sunriver)	X			
Deschutes County Sheriff's Office - Terrebonne (8222 Hwy 97, Terrebonne)	X			

Source: DOGAMI 2007. Open File Report 0-07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.

Existing Authorities, Policies, Programs, and Resources

Existing authorities, policies, programs, and resources include current mitigation programs and activities that are being implemented by city, county, regional, state or federal agencies and/or organizations.

County and Cities

At an individual level, preparedness for an earthquake is minimal as perception and awareness of earthquake hazards are low. Strapping down heavy furniture, water heaters and expensive personal property as well as having earthquake insurance are steps toward earthquake mitigation.

City and county building officials enforce building codes for new construction and can coordinate inspection activities in the event of an earthquake. Deschutes County has also mapped critical facilities and major public buildings and inspections of these facilities can be assigned quickly when an earthquake occurs.

State

The Oregon State Building Codes Division adopts statewide standards for building construction that are administered by the state, cities and counties throughout Oregon. The codes apply to new construction and to the alteration of, or addition to, existing structures. Within these standards are six levels of design and engineering specifications for seismic safety that are

applied to areas according to the expected degree of ground motion and site conditions. The structural code requires a site-specific seismic hazard report for critical facilities such as hospitals, fire and police stations, emergency response facilities, and special occupancy structures, such as schools and prisons. The seismic hazard report required by the structural code for essential facilities and special occupancy structures considers factors such as the seismic zone, soil characteristics including amplification and liquefaction potential, any known faults, and potential landslides. The findings of the seismic hazard report must be considered in the design of the building. The residential code incorporates prescriptive requirements for foundation reinforcement and framing connections based on the applicable seismic zone for the area.

Retrofitting of existing buildings may be required when such buildings are altered or their occupancy is changed. Requirements vary depending on the type and size of the alteration and whether there is a change in the use of the building that is considered more hazardous.

Hazard Mitigation Action Items

There are three identified Earthquake action items for Deschutes County; in addition, several of the Multi-Hazard action items affect the earthquake hazard. An action item matrix is provided within Volume I, Section 3, while action item forms are provided within Volume IV, Appendix A. To view city actions see the appropriate city addendum within Volume III.

Significant Changes since the 2015 Plan

This section includes one significant change from 2015; updated information on the National Flood Insurance program. In addition, the format of the section and minor content changes have been made.

Causes and Characteristics of the Hazard

Flooding results when rain and snowmelt creates water flow that exceeds the carrying capacity of rivers, streams, channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall. Most of Oregon's destructive natural disasters have been floods.¹ Flooding can be aggravated when rain is accompanied by snowmelt and frozen ground; the spring cycle of melting snow is the most common source of flood in the region.

Anticipating and planning for flood events is an important activity for Deschutes County. Federal programs provide insurance and funding to communities engaging in flood hazard mitigation. The Federal Emergency Management Association (FEMA) manages the National Flood Insurance Program (NFIP) and the Hazard Mitigation Grant Program (HMGP). The NFIP provides flood insurance and pays claims to policyholders who have suffered losses from floods. The HMGP provides grants to help mitigate flood hazards by elevating structures or relocating or removing them from flood hazard areas. These programs provide grant money to owners of properties who have suffered losses from floods, and in some cases, suffered losses from other natural hazard events.

Flood Sources

The principal flood sources in Deschutes County include: Deschutes River, Little Deschutes River, Paulina Creek, Whychus Creek, and Spring River.²

Flood Types

The principal types of flood that occur in Deschutes County include:

- Rain-on-Snow (warm winter) flooding
- Spring/Snowmelt flooding
- Ice jams/Frazil ice
- Flash floods
- Dam failure

¹ Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. 1999

² FEMA, Deschutes County Flood Insurance Study, revised September 28, 2007.

The most common of these potential flooding events in Deschutes County is a rain-on-snow event.³

Rain-on-Snow

The weather pattern that produces these floods occurs during the winter months and has come to be associated with La Nina events, a three to seven year cycle of cool, wet weather. Brief, cool, moist weather conditions are followed by a system of warm, moist air from tropical latitudes. The intense warm rain associated with this system quickly melts foothill and mountain snow. Above-freezing temperatures may occur well above pass levels in the Cascade Mountains (4,000-5,000 feet).⁴

Spring/Snowmelt Flooding

Snowmelt floods occur in the spring and early summer when temperatures rise rapidly, causing rapid melting of accumulated snow. Spring runoff has caused significant riverine flooding in the County, resulting in damage along the Deschutes, Little Deschutes and Spring Rivers, in addition to Paulina and Whychus Creeks, and several smaller rivers and creeks. Most spring flooding has been precipitated by a particular combination of factors: ground saturation followed by a heavy ground freeze, a heavy snowpack in higher elevations, and then spring rains and winds causing sudden snow melt.

Ice Jams

Ice jams on the Deschutes River have created flood conditions in the past and will continue to do so due to local topography. This type of flood is also associated with Frazil Ice, which contributes to jamming (particularly upstream of the former log pond formed by Shevlin Dam). Ice jams commonly happen during the winter and early spring, while the river is still frozen. Sudden warming at higher altitudes can melt waters resulting in increased runoff of water and ice into large reaches of frozen river below. On the way downstream, the ice can “jam” in narrow places on the river or against a road crossing, effectively damming the river, sometimes followed by a sudden breach and release of the water and ice.

Flash Floods

Flash floods usually result from intense storms dropping large amounts of rain within a brief period. They usually occur in the summer during the thunderstorm season, appear with little or no warning and can reach full peak in only a few minutes. They are most common in arid and semi-arid areas of Oregon like Deschutes County where there is often steep topography, little vegetation and intense but short-duration rainfall. This situation would be typified by the eastern part of Deschutes County and areas without permanent streams such as the dry canyon west of Redmond.

³ Ibid.

⁴ Ibid.

Dam Failure (Natural or man-made)

Major flooding could also result from partial or complete failure of natural dams (mountain streams that begin in glacial lakes behind dams of ice or moraines can occasionally be emptied rapidly and result in flash floods with accompanying mud flows) or man-made structures, constructed to restrict the flow of water on the county's waterways, either impounding reservoirs or diversion dams.

These types of floods are often associated with flash floods. In such situations, waters not only rise rapidly, but also generally move at high velocities and often carry large amounts of debris. In these instances a flash flood may arrive as a fast moving wall of debris, mud, water or ice. Such material can accumulate at a natural or man-made obstruction and restrict the flow of water. Water held back in such a manner can cause flooding both upstream and then later downstream if the obstruction is removed or breaks free.

Manmade dam failures can occur rapidly and with little warning. Fortunately, most failures result in minor damage and pose little or no risk to life safety. However, the potential for severe damage still exists. The Oregon Water Resources Department has inventoried all dams located in Oregon and Deschutes County. There are five dams categorized as high hazard; North Canal Diversion, Crescent Lake, Crane Prairie Dam, Wickiup Dam, and the Sunriver Effluent Lagoon.⁵

Another area of heightened concern focuses on the potential of flooding related to the failure of glacial moraine dams that impound high-altitude lakes around the Three Sisters and Broken Top. In the event of volcanic eruption, earthquake or a large avalanche of rock or ice into the lakes, these dams could release floods of water and debris whose major impact could inundate parts of local areas. A moraine dam impounding a small unnamed lake high on the east side of Broken Top failed in October, 1966, generating a debris flow that traveled down the Soda Creek drainage, across Highway 46 (Cascade Lakes Highway), and spread out over the broad meadow near Sparks Lake. The debris flow buried the road and covered about 250,000 square meters (about 2,700,000 square feet) of the meadow with sand and silt.⁶

Carver Lake is a moraine-dammed lake on the eastern flank of South Sister volcano. The lake sits approximately 20 km upstream from the community of Sisters, Oregon, located in the valley below. The outlet channel of Carver Lake is a small tributary of Whychus Creek, which flows through downtown Sisters. In the 1980s, concern was raised regarding the flooding risk posed to the Sisters community, should a moraine-dam failure lead to an outburst flood from Carver Lake. Modeling conducted at the time suggested that, in the event of complete lake drainage, the flooding hazard could be substantial (Laenen et al., 1987).

There is consensus among geologists and engineers who have visited Carver Lake (e.g., Laenen et al., 1987; O'Connor et al., 2001) that the moraine dam appears stable to spontaneous failure, and that a failure would most likely require overtopping waves generated by a landslide entering the lake. Compared to earlier studies and coarse topography, recent modeling suggests a strikingly different result for our test case involving inundation near Sisters, Oregon. Owing in part to the use of 2-D equations as well as high-resolution lidar topography, recent results

⁵ Source: Oregon water Resources Department, "Dam Inventory Query", http://apps.wrd.state.or.us/apps/misc/dam_inventory/, Accessed January 2021.

⁶ O'Connor, J.E., J.H. Hardison and J.E. Costa. 2001. Debris flows from failures of Neoglacial-Age moraine dams in the Three Sisters and Mount Jefferson wilderness areas, Oregon. US Geological Survey Professional Paper 1606.

suggest that flow avulsion and diversion on the alluvial fan surrounding Sisters would lead to a less severe flood hazard to the community.⁷ However, model results still suggest widespread shallow flooding in the Sisters Area from moraine-dam failure with depths between 1 to 3 meters along existing and historical drainage channels and in excess of 3 meters in some limited areas, including the City of Sisters wastewater treatment lagoons.⁸

Lesser hazards include several small lakes at the headwaters of Whychus Creek and the basin (currently with no lake) below Collier Glacier at the head of White Branch, and the unnamed lake on the east side of Broken Top which could trigger floods or debris flows in the Soda Creek drainage or the Tumalo Creek drainage.⁹

History of Floods in Deschutes County¹⁰

Generally, river flooding has not historically been a serious problem in Deschutes County. This is mostly due to the porous nature of the underlying volcanic rock that has a large capacity for water storage, irrigation diversion canals and reservoir retention. Consequently, the discharge rate for the Deschutes River is very low considering the size of its basins. Regular flooding events have occurred however near the headwaters of Tumalo Creek and in the Tumalo community. Along Whychus Creek, the city of Sisters frequently experiences flooding, with the most significant event occurring in 1964.

The flood season on the Deschutes River extends from November through July (larger floods downstream of the Little Deschutes River typically occur in November and December). The flood of record on the Deschutes River upstream of the Little Deschutes River occurred on July 30, 1956 (discharge of 2,280 cfs, approximately a 40-year event); the flood of record on the Deschutes River downstream of the Little Deschutes River occurred on November 27, 1909 (discharge of 5,000 cfs at Benham Falls stream gage). The largest flood since 1958 occurred downstream of the Little Deschutes River in December 1964 (discharge of 3,470 cfs at Benham Falls stream gage, approximately a 175-year event).

The flood season on the Little Deschutes River extends from October through June (majority occur from April to June). Generally there are more days above bankfull stage during the spring (during spring snowmelt floods) than winter. The flood of record occurred in December 1964 (discharge of 3,660 cfs at RM 28.1 north of La Pine, greater than a 500-year event). There are ten bridges within the FIS study area for the Little Deschutes River, of those only the Ranch Bridge (RM 15.1) may be over topped by the 1-percent-annual-chance flood (100-year flood event); however the Vandervert Ranch Bridge (RM 3.1), Lazy River South Ranch Bridge (RM 16.6), Stearns Ranch Bridge (RM 28.1), and the Masten Bridge (RM 39.9) and their approaches may also be over topped by the 0.2-percent-annual-chance flood (500-year flood event).

The flood season on Whychus Creek extends from November through April (larger events occur November and December). The flood of record occurred on December 25, 1980 (discharge of

⁷ George et al. Seamless numerical simulation of a hazard cascade in which a landslide triggers a dam-breach flood and consequent debris flow, 7th International Conference on Debris-Flow Hazards Mitigation, 2019.

⁸ Ibid.

⁹ Hydrologic Hazards Along Whychus Creek From a Hypothetical Failure of the Glacial Moraine Impacting Carver Lake Near Sisters, Oregon—USGS Open File Report 87-41

¹⁰ FEMA, Deschutes County Flood Insurance Study, revised September 28, 2007. Most of the information in this section was obtained from the FIS, additional footnotes are provided as applicable.

2,000 cfs at RM 26.6, approximately an 80-year event). Debris deposition on agricultural land damaging irrigation diversion works, bank erosion, and property damage in Sisters are the principle flood concerns. There are 12 bridges within the FIS study area for Whychus Creek, of those only the ranch bridge (RM 16.3) and the Elm Street Bridge (RM 21.8 in Sisters) may be over topped by the 1-percent-annual-chance flood (100-year flood event); however the ranch bridges at RM 19.3 and RM 19.4 and their approaches may also be over topped by the 0.2-percent-annual-chance flood (500-year flood event).

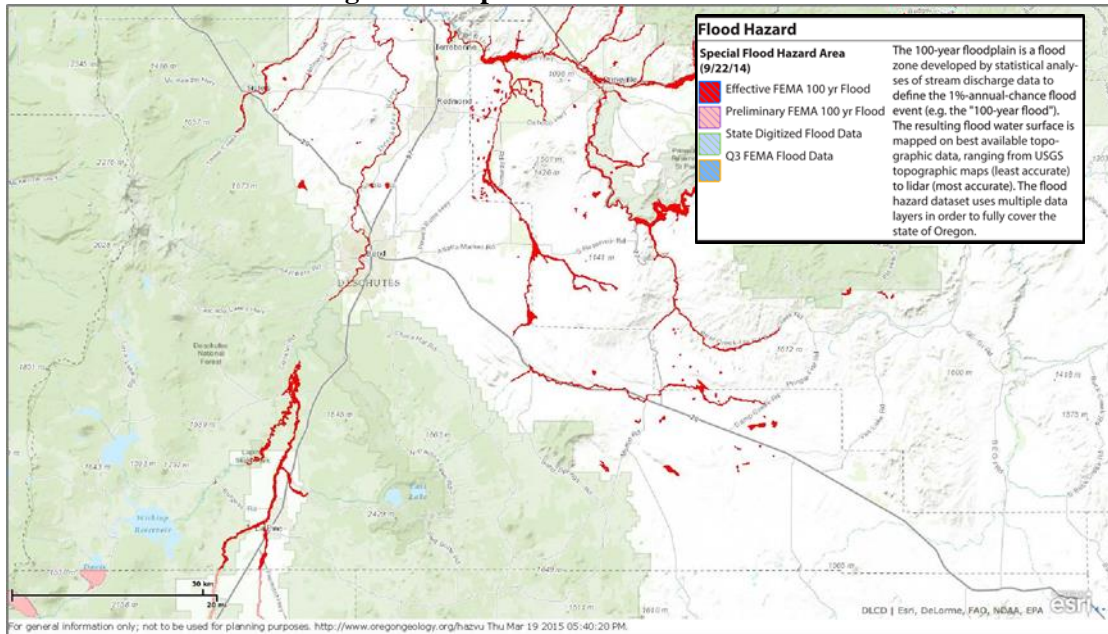
The Whychus Creek stream corridor is particularly vulnerable to obstructions to flood flows due to unconsolidated volcanic deposits that make up the streambed and banks that are prone to erosion. This concern is exacerbated in areas that are at, or below, the elevation of the streambank (see Sisters Addendum for more information). In addition, there is the potential for the moraine dam at Carver Lake to fail during an earthquake, volcanic event, or avalanche/landslide (the lake contains approximately 740 acre feet of water). There have been three observed failures of the dam in the recent past.

More information on the history of the flood hazard can be found in the [Regional Risk Assessment for Region 6 of the 2020 Oregon NHMP](#).

Hazard Identification

FEMA Flood Insurance Rate Maps (FIRMs) and the accompanying Flood Boundary and Floodway maps are the most comprehensive resource for identifying areas subject to flood hazards in Deschutes County. FIRMs and Floodway maps delineate the boundaries of areas subject to inundation by the “base flood.” The base flood is defined as an event having a 100-year recurrence interval or a 1% probability of occurring in any year. The maps also provide, in areas of detailed study, projected water surface elevations for the base flood. In general, based on experience with the flood events of the past several decades, Deschutes County’s FIRM maps have proven to be fairly accurate in depicting areas subject to riverine flooding. There have been no large flood events since the FIRMs were issued in the mid-1980s so the accuracy of the maps in relation to large flood events is untested. The special flood hazard area is depicted in the map below, for more detailed information visit the Oregon Risk MAP website and click on the “Mapping Tools” tab: <http://www.oregonriskmap.com/>.

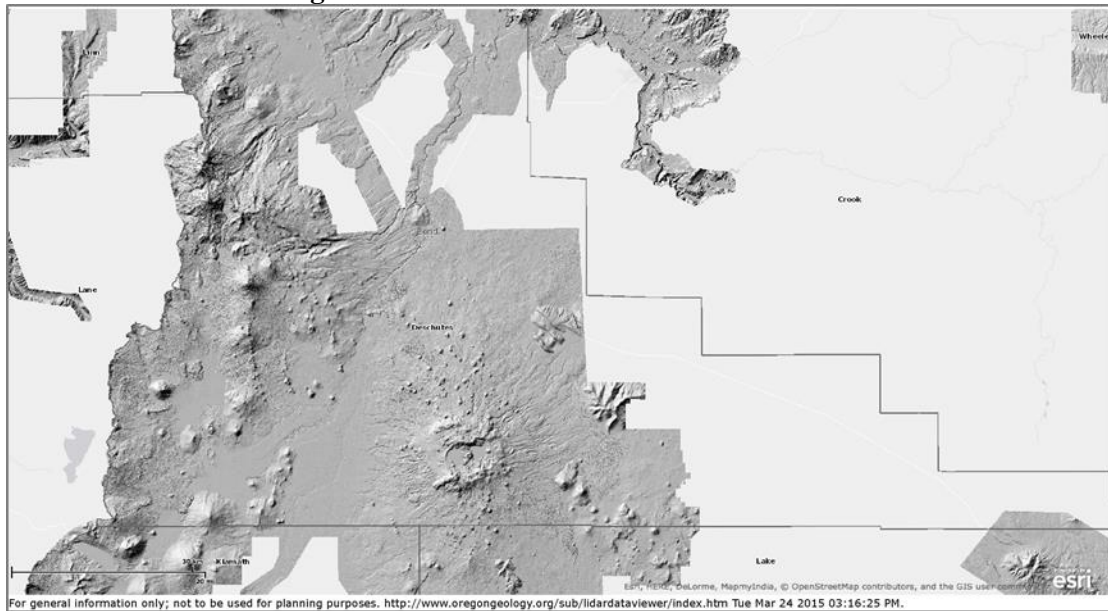
Figure II-7 Special Flood Hazard Area



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu), accessed March 18, 2015

The county's FIRMs were modernized in 2007, however, there is a concern that sediment accumulation may be occurring within the Deschutes River (and other waterways) that may impact the special flood hazard area. The county has included an action to update the flood insurance study and flood insurance rate maps utilizing existing Lidar. The figure below shows the extent of collected Lidar within Deschutes County, it shows that the areas of the mapped special flood hazard areas are included within the collected Lidar. Although the county is not currently slated to undergo a flood study/mapping project, the existing Lidar data may be useful in conducting future projects.

Figure II-8 Shaded Relief of Collected Lidar



Source: DOGAMI Lidar Data Viewer, accessed March 24, 2015

National Flood Insurance Program (NFIP)

The Deschutes County Flood Insurance Rate Maps (FIRMs) were modernized in September 2007. The table below shows that as of January 2021, Deschutes County (including the incorporated cities) has 267 National Flood Insurance Program (NFIP) policies (90 of these are for properties developed before the initial FIRM) in force and eight total paid claims. The last Community Assistance Visit (CAV) for Deschutes County was on July 22, 1994 (the most recent CAV was in Sisters on April 26, 2004). The county and cities are not members of the Community Rating System (CRS). The table displays the number of policies by building type and shows that the majority of residential structures that have flood insurance policies are single-family homes and that there are 14 non-residential structures with flood insurance policies. According to data from 2021, the proportion of single-family homes (excluding condominiums) within the mapped special flood hazard area (SFHA, floodplain) that have flood insurance (the market penetration rate) for Deschutes County is 12.7%.

The Community Repetitive Loss record for Deschutes County, Bend, La Pine, Redmond, and Sisters identifies zero repetitive loss buildings, zero severe repetitive loss buildings, and zero total repetitive loss claims.

Table II-5 Flood Insurance Detail

Jurisdiction	Current FIRM Date	Initial FIRM Date	Total Policies	Pre-FIRM Policies	Policies by Building Type				Minus Rated A Zone
					Single Family	2 to 4 Family	Other Residential	Non-Residential	
Deschutes County*	9/28/2007	9/29/1986	126	66	126	0	0	0	11
Bend	9/28/2007	9/4/1987	60	21	50	3	1	1	1
La Pine	9/28/2007	9/28/2007	1	1	1	0	0	0	0
Redmond	9/28/2007	9/28/2007	0	0	0	0	0	0	0
Sisters	9/28/2007	9/29/1986	31	2	31	0	0	0	2

Jurisdiction	Insurance in Force	Total Paid Claims	Pre-FIRM Claims Paid	Substantial Damage Claims	Repetitive Loss Buildings	Severe Repetitive		Total Paid Amount	CRS Class Rating	Last CAV
						Loss Buildings	Loss Buildings			
Deschutes County	\$67,891,200	8	5	0	1	0	0	\$65,507	-	-
County*	\$36,129,300	3	1	0	1	0	0	\$15,115	NP	7/22/1994
Bend	\$21,792,700	5	4	0	0	0	0	\$50,392	NP	7/20/1994
La Pine	\$280,000	0	0	0	0	0	0	\$0	NP	NA
Redmond	\$0	0	0	0	0	0	0	\$0	NP	NA
Sisters	\$9,689,200	0	0	0	0	0	0	\$0	NP	4/26/2004

* Portion of entire county under county jurisdiction
 NP - Not Participating NA - Information not Available/ Not Applicable

Source: Information compiled by FEMA, January 2021

Probability Assessment

USGS scientists and US Army Corps of Engineers studies indicate the county is at a low level of risk for catastrophic flooding. Potentially, the Little Deschutes and Whychus Creek are most vulnerable; however greater risks are related to future volcanic eruptions (see Volcano annex).

The Federal Emergency Management Agency (FEMA) has mapped the 10, 50, 100, and 500-year floodplains in the Region 6 counties. This corresponds to a 10%, 2%, 1% and 0.2% chance of a certain magnitude flood in any given year. In addition, FEMA has mapped the 100-year floodplain (i.e., 1% flood) in the incorporated cities. The 100-year flood is the benchmark upon which the National Flood Insurance Program (NFIP) is based.

As such, Deschutes County’s Natural Hazards Mitigation Steering Committee believes that the County’s **probability of experiencing a flood is “high”**, meaning one incident is likely within the next 10 – 35 year period. Based upon available information the Oregon NHMPs Regional Risk Assessment rates Deschutes County’s probability of flood as low.¹¹

Vulnerability Assessment

Growth rates described in the Community Profile section of this Plan project a continued growth pattern that will place additional development, business and human life at risk.

The Deschutes County Natural Hazards Steering Committee rated Deschutes County as having a **“low” vulnerability to the flood hazard**, meaning less than 1% of the region’s population or assets would be affected by a major emergency or disaster. Based upon available information

¹¹ 2020 Oregon Natural Hazard Mitigation Plan. Department of Land Conservation and Development, 2020.

the Oregon NHMPs Regional Risk Assessment rates Deschutes County's vulnerability to flood as very low.¹²

Sisters is particularly vulnerable to economic loss in the event of road closures. According to USGS Open File Report 87-41, locally high velocities, damming, erosion and sediment deposit could cause considerable property damage and possible loss of life. The stream would be especially dangerous at road crossings where bridges may fail or sections could wash away.

Risk Analysis

The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section), and (2) the likelihood or probability of the harm occurring. Table 2-6 of the Risk Assessment (Volume I, Section 2) shows the county's Hazard Analysis Matrix which scores each hazard and provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard. Based on the matrix the **flood hazard is rated #7, out of 9 rated hazards, with a total score of 114.**

Community Hazard Issues

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

If not properly protected from the entry of flood waters, mechanical, electrical and similar equipment can also be damaged or destroyed by flooding.

Older, pre-FIRM manufactured homes are particularly susceptible to flood damage, as many have a lower level of structural stability than "stick-built" (standard wood frame construction) homes. Current regulations require manufactured homes in floodplain zones to be both elevated and anchored to provide structural stability during flood events comparable to site built homes.

Flood events impact businesses by damaging property and interrupting commerce. Flood events can cut off customer access and close businesses for repairs. A quick response to the needs of businesses affected by flood events can help a community maintain economic viability in the face of flood damage.

¹² Ibid.

Bridges are a major concern during flood events as they provide critical links in road networks by crossing water courses and other significant natural features. However bridges and their supporting structures can also be obstructions in flood-swollen watercourses and can be damaged by debris jams and erosion scour.

More information on this hazard can be found in the [Regional Risk Assessment for Region 6](#) of the Oregon NHMP.

Existing Authorities, Policies, Programs, and Resources

Existing authorities, policies, programs, and resources include current mitigation programs and activities that are being implemented by city, county, regional, state or federal agencies and/or organizations.

County and Cities

Current initiatives to mitigate the effects of potential flooding in Deschutes County are many. These actions are varied from projects initiated by homeowners and neighborhood associations to county policies and procedures aligned with the National Flood Insurance Program.

Home and business owners and neighborhood associations in and around the County's floodplains continue to address mitigation activities for flooding. Riparian zones have been established to reduce erosion, review of building plans/codes and emergency strategies to mitigate damage from floods are being developed.

Regardless of future investigative studies, some early warning, zoning, and planning studies are needed to prevent loss of life and property damage in areas downstream of Carver Lake. In Sisters, the potential breakout of Carver Lake represents several times the magnitude flood for which county and city governments presently plan. The flood could occur with little or no warning.

The city of Sisters is currently engaged in discussions about potential flooding from the Carver Lake scenario described above and other flooding potential. The current belief by city planners is that a rain-on-snow event is more likely to occur than a breach at Carver Lake. Therefore, the City of Sisters will continue to pursue mitigation policies that address local flooding of Whychus Creek.

Deschutes County Comprehensive Plan and Development Code

Deschutes County has enacted a Comprehensive Land Use Plan and is implementing land use regulations in compliance with ORS 197 and the Statewide Planning Goals. The County has enacted and enforces a flood hazard ordinance, which is applied to all areas mapped as subject to inundation by the base flood. The regulations are designed to reduce the risk of flood damage to new and substantially improved structures within known flood hazard areas.

Deschutes County Public Works

Deschutes County annually visually inspects and cleans culverts on county roads. Culverts needing replaced are identified and targeted for replacement. Culverts during past flooding events that could not handle the flow are looked at for replacement with a larger culvert.

Bridges are likewise routinely inspected and during flood events crews keep a visual check on bridges for debris buildup. After a major flood, crews are dispatched to recheck bridges for flood damage.

Federal

National Flood Insurance Program

Deschutes County participates in the National Flood Insurance Program, which enables property and business owners to qualify for federally underwritten flood insurance. Flood insurance policies in effect in the County and the coverage provided by these policies are depicted above. The County's flood ordinance, discussed above, comprises the county's NFIP qualifying floodplain regulation. These standards require all new development to be elevated above the projected level of the base flood, along with a number of other building design and construction standards intended to reduce the risk of flood damage. Strict enforcement of these regulations is required to maintain eligibility for participation in the NFIP; the Community Development Department is charged with this responsibility.

Hazard Mitigation Action Items

There are seven identified Flood action items for Deschutes County; in addition, several of the Multi-Hazard action items affect the Flood hazard. An action item matrix is provided within Volume I, Section 3, while action item forms are provided within Volume IV, Appendix A. To view city actions see the appropriate city addendum within Volume III.

Significant Changes since the 2015 Plan

Significant changes to this section include additions to Community Hazard Issues, additional information on the history of landslides, and an updated Figure II-9.

Causes and Characteristics of the Hazard

Landslides are a major geologic threat in almost every state in the United States. In Oregon, a significant number of locations are at risk from dangerous landslides and debris flows. While not all landslides result in property damage, many landslides do pose serious risk to people and property. Increasing population in Oregon and the resultant growth in home ownership has caused the siting of more development in or near landslide areas. Often these areas are highly desirable to prospective homeowners owing to their location along the coast, rivers and on hillsides.

Landslides are fairly common, naturally occurring events in various parts of Oregon. In simplest terms, 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.

Landslides can be grouped as “on-site” and “off-site” hazards. An “on-site” slide is one that occurs on or near a development site and is usually relatively slow moving. Slow moving slides cause the most property damage in developed areas. On-site landslide hazards include features called slumps, earthflows and block slides. “Off-site” slides typically are rapidly moving and begin on steep slopes at a distance from homes and development. A 1996 “off-site” slide in southern Oregon began a long distance away from homes and roads, traveled at a high velocity and resulted in five fatalities and a number of injuries, in addition to substantial property damage.

Landslides are classified based on causal factors and conditions and exist in three basic categories.

Falls

This type of landslide involves the movement of rock and soil which detaches from a steep slope or cliff and falls through the air and/or bounces or rolls down the slope. This type of slide is termed a rock fall and is very common along Oregon highways where they have been cut through bedrock in steep canyons and along the coast.

Slides

This type of landslide exists where the slide material moves in contact with the underlying surface. Here the slide moves along a plane and either slumps by moving along a curved surface (called a rotational slide) or along a flat surface (called a translational slide). While slow-moving slides can occur on relatively gentle slopes and are less likely to cause serious injuries or fatalities, they can result in significant property damages.

Flows

Flow landslides are characterized as plastic or liquid in nature where the slide material breaks up and flows during movement. A flow occurs when a landslide moves down slope as a semi-fluid mass scouring or partially scouring rock and soils from the slope along its path. A flow landslide is typically rapidly moving and tends to increase in volume as it moves down slope and scours out its channel.

Rapidly moving flow landslides are often referred to as debris flows. Other terms given to debris flows are mudslides, mudflows, or debris avalanches. Debris flows frequently take place during or following an intense rainfall event on previously saturated soil. Debris flows usually start on steep hillsides as slumps or slides that liquefy, accelerate to speeds as high as 35 miles per hour or more, and travel down slopes and channels onto gentle sloping or flat ground. Most slopes steeper than 70 percent are at risk from debris flows.

The consistency of a debris flow ranges from watery mud to thick, rocky, mud-like, wet cement which is dense enough to carry boulders, trees and cars. Separate debris flows from different starting points sometimes combine in canyons and channels where their destructive energy is greatly increased. Debris flows are difficult for people to outrun or escape from and present the greatest risk to human life. Debris flows have caused most of their damage in rural areas and were responsible for most of the landslide-related deaths and injuries during the 1996 storms in Oregon.

Conditions Affecting Landslides

Natural conditions and human activities can both play a role in causing landslides. Certain geologic formations are more susceptible to landslides than others. Locations with steep slopes are at the greatest risk of slides. However, the incidence of landslides and their impact on people and property can be accelerated by development. Developers who are uninformed about geologic conditions and processes may create conditions that can increase the risk of or even trigger landslides.

There are four principal factors that affect or increase the likelihood of landslides:

1. Natural conditions and processes including the geology of the site, rainfall, wave and water action and seismic tremors, including earthquakes and volcanic activity.
2. Excavation and grading on sloping ground for homes, roads and other structures.

3. Drainage and groundwater alterations that are natural or human-caused can trigger landslides. Human activities that may cause slides include broken or leaking water or sewer lines, water retention facilities, irrigation and stream alterations, ineffective storm water management and excess runoff due to increased impervious surfaces.
4. Change or removal of vegetation on very steep slopes due to timber harvesting, land clearing and wildfire.

History of Landslides in Deschutes County

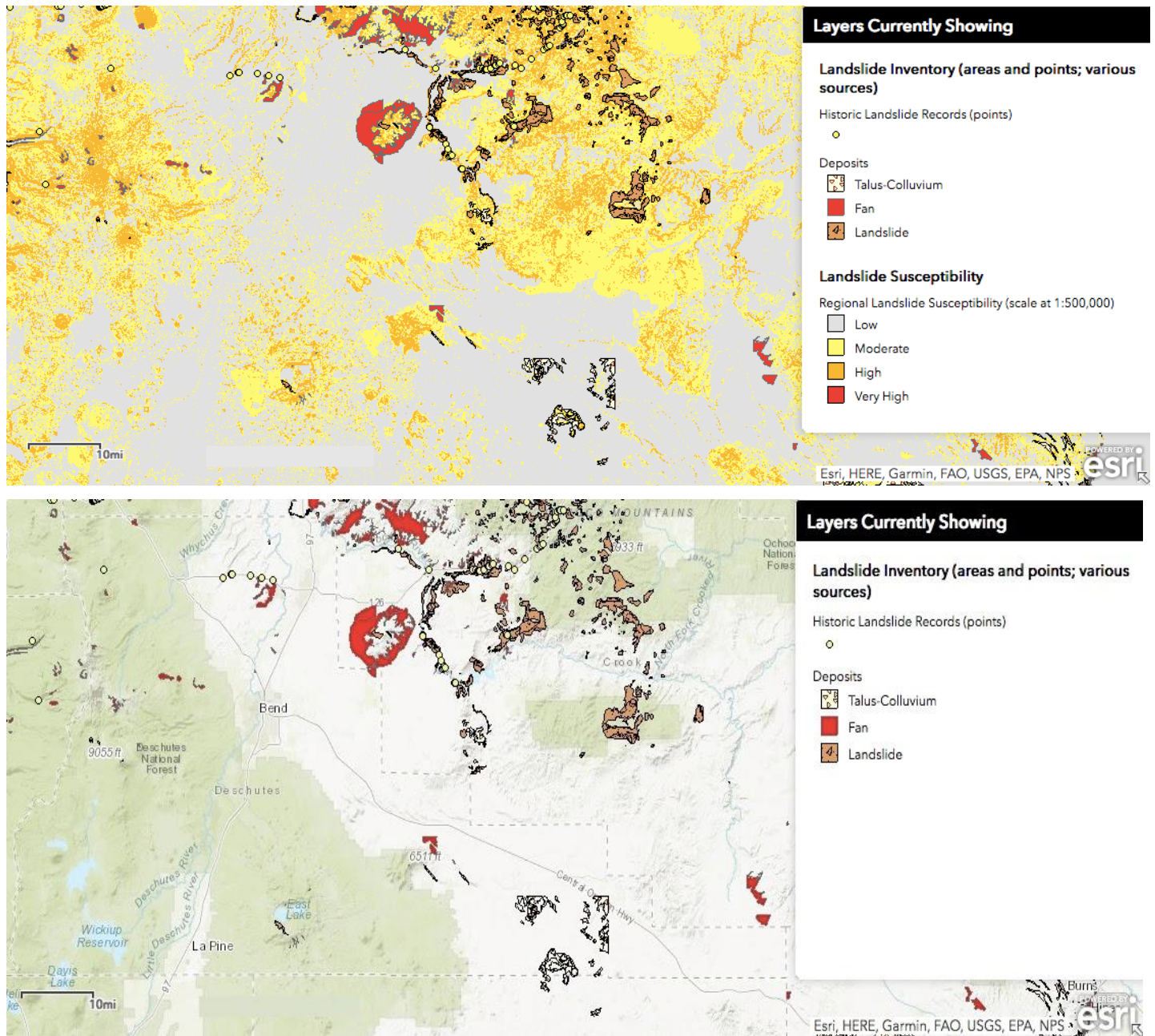
Although most landslides occur in the undeveloped forested areas of the county, landslides may also occur in more developed areas. The fatalities and losses resulting from the 1996 statewide landslide events brought about the passage of Oregon Senate Bill 12, which set site development standards, authorized the mapping of areas subject to rapidly moving landslides and the development of model landslide (steep slope) ordinances.

There is no history of major landslides in Deschutes County within developed areas. At times small debris falls have occurred, however, these have typically not caused major disruptions of normal activity (see figure below). In undeveloped areas the risk of landslides and avalanches is highest within the forested areas and in the Three Sisters Wilderness. There have been recorded landslides that affected the Carver Lake moraine dam and other rural areas; however, this activity has not led to major disruptions of normal activity.

DOGAMI maps the State Landslide Information Layer for Oregon (SLIDO); Figure II-9 relies on the 2012 SLIDO data and shows Deschutes County landslides that have been identified on published maps. The database contains only landslides that have been located on these maps. Many landslides have not yet been located or are not on these maps and therefore are not in this database. This database does not contain information about relative hazards.¹ The map shows that the history of landslide events is sparse, and where they do occur they are in non-populated areas.

¹ DOGAMI. Statewide Landslide Information Database for Oregon (SLIDO-2).
<http://www.oregongeology.org/sub/slido/index.htm>

Figure II-9 Mapped Landslides and Landslide Susceptibility



Source: DOGAMI Statewide Landslide Information Database for Oregon (SLIDO), accessed February 10, 2021.

Hazard Identification

Geologic and geographic factors are important in identifying landslide-prone areas. Stream channels, for example, have major influences on landslides, due to undercutting of slopes by stream erosion and long-term hillside processes.

The Oregon Department of Forestry (ODF) Storm Impacts Study conducted after the 1996-97 landslide events found that the highest probability for the initiation of shallow, rapidly moving landslides was on slopes of 70 to 80 percent steepness. A moderate hazard of shallow rapid landslide initiation can exist on slopes between 50 and 70 percent.²

In general, areas at risk to landslides have steep slopes (25 percent or greater,) or a history of nearby landslides. In otherwise gently sloped areas, landslides can occur along steep river and creek banks. At natural slopes under 30 percent, most landslide hazards are related to excavation and drainage practices, or the reactivation of preexisting landslide hazards.³

The severity or extent of landslides is typically a function of geology and the landslide triggering mechanism. Rainfall initiated landslides tend to be smaller, and earthquake induced landslides may be very large. Even small slides can cause property damage, result in injuries, or take lives. Geo-engineers with the Oregon Department of Forestry estimate widespread landslide activity about every 20 years.

The Department of Land Conservation and Development (DLCD) requires local governments to address geologically unstable areas as part of their comprehensive plans through Statewide Land Use Planning Goal 7 (Areas Subject to Natural Hazards). In Deschutes County, little planning has been done concerning landslide hazards due to the lack of risk. Goal 7 envisions a process whereby new hazard inventory information generated by federal and state agencies is first reviewed by DLCD. DLCD then notifies the County of the new information, and the County has three years to respond to the information by evaluating the risk, obtaining citizen input, and adopting or amending implementation measures to address the risk. Deschutes County has not received notice of new inventory information concerning 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); consequently, the Oregon Department of Forestry tracks storms during the rainy season, monitors rain gages and snow melt, and issues warnings as conditions warrant. Given the correlation between precipitation / snow melt and rapidly moving landslides, it would be feasible to construct a probability curve. 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.

² Storm Impacts and Landslides of 1996 Final Report. (1999) Oregon Department of Forestry.

³ Oregon Natural Hazards Mitigation Plan, Landslide Chapter. The Interagency Hazards Mitigation Team, (2012) Oregon Military Department - Office of Emergency Management.

Deschutes County’s Natural Hazards Mitigation Steering Committee believes that the County’s **probability of experiencing a landslide is “moderate,”** meaning one incident is likely within the next 35-75 year period. Based upon available information the Oregon NHMPs Regional Risk Assessment rates Deschutes County’s probability of landslide as low.⁴

Vulnerability Assessment

To a large degree, landslides are very difficult to predict. Both location and extent of landslide hazard are affected by a variety of variables. Many people are unaware of their exposure to landslide risk. Therefore there are a large number of structures, infrastructure, and other community assets within Deschutes County potentially vulnerable to landslides. New private development is subject to regulations which are intended to reduce risk from known landslide hazards. However, there is substantial private development in the county, which pre-dates land use or building code regulations and is therefore subject to increased risk.

The Deschutes County Natural Hazards Steering Committee rated Deschutes County as having a **“low” vulnerability to landslide hazards;** meaning less than 1% of the region’s population or assets would be affected by a major emergency or disaster. Based upon available information the Oregon NHMPs Regional Risk Assessment supports this vulnerability rating for Deschutes County (“very low”).⁵

Risk Analysis

The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section), and (2) the likelihood or probability of the harm occurring. Table 2-6 of the Risk Assessment (Volume I) shows the county’s Hazard Analysis Matrix which scores each hazard and provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard. Based on the matrix the **landslide hazard is rated #9, out of 9 rated hazards, with a total score of 87.**

Community Hazard Issues

Depending upon the type, location, severity and area affected, severe property damage, injuries and loss of life can be caused by landslide hazards. Landslides can damage or temporarily disrupt utility services, roads and other transportation systems and critical lifeline services such as police, fire, medical, utility and communication systems, and emergency response. In addition to the immediate damage and loss of services, serious disruption of roads, infrastructure and critical facilities and services may also have longer term impacts on the economy of the community and surrounding area. Additionally, the Carver Lake dam has been identified as a hazard risk to the city of Sisters that can be triggered by a landslide event. For more information on the Carver Lake dam risks, please see the Flood Annex.

⁴ 2020 Oregon Natural Hazard Mitigation Plan. Department of Land Conservation and Development, 2020.

⁵ Ibid.

Increasing the risk to people and property from the effects of landslides are the following seven factors:

1. Improper excavation practices, sometimes aggravated by drainage issues, can reduce the stability of otherwise stable slopes.
2. Allowing development on or adjacent to existing landslides or known landslide-prone areas raises the risk of future slides regardless of excavation and drainage practices. Homeowners and developers should understand that in many potential landslide settings that there are no development practices that can completely assure slope stability from future slide events.
3. Building on fairly gentle slopes can still be subject to landslides that begin a long distance away from the development. Sites at greatest risk are those situated against the base of very steep slopes, in confined stream channels (small canyons), and on fans (rises) at the mouth of these confined channels. Home siting practices do not cause these landslides, but rather put residents and property at risk of landslide impacts. In these cases, the simplest way to avoid such potential effects is to locate development out of the impact area, or construct debris flow diversions for the structures that are at risk.
4. Certain forest practices can contribute to increased risk of landslides. Forest practices may alter the physical landscape and its vegetation, which can affect the stability of steep slopes. Physical alterations can include slope steepening, slope-water effects, and changes in soil strength. Of all forest management activities, roads have the greatest effects on slope stability, although changing road construction and maintenance practices are reducing the effects of forest roads on landslides.
5. Deschutes County is susceptible to extreme winter storms and rainfall. High rainfall accumulation in a short period of time increases the probability of landslides.
6. Removal of vegetation from fire significantly increases the risk of landslides, especially as fires become more frequent and more intense due to climate change.
7. Climate change is causing an increase in large, high-intensity fires across the west. Models predict that climate change will result in more extreme winter storms and rainfall in the Pacific Northwest. Climate change is causing glaciers to decrease in size, and, in some locations, to melt completely. As glacial ice is removed from steep mountain slopes the likelihood of rock fall, landslides, and debris flows increases.

More information on this hazard can be found in the Regional Risk Assessment for Region 6 of the Oregon NHMP.

Existing Authorities, Policies, Programs, and Resources

Existing authorities, policies, programs, and resources include current mitigation programs and activities that are being implemented by city, county, regional, state or federal agencies and/or organizations.

State

Oregon Department of Forestry (ODF)

The Oregon Department of Forestry has provided a preliminary indication of debris flows (rapidly moving landslides) in Western Oregon. Their debris flow maps include locations subject

to naturally occurring debris flows and include the initiation sites and locations along the paths of potential debris flows (confined stream channels and locations below steep slopes). These maps neither consider the effects of management-related slope alterations (drainage and excavation) that can increase the hazard, nor do they consider very large landslides that could possibly be triggered by volcanic or earthquake activity. Areas identified in these maps are not to be considered “further review areas” as defined by Senate Bill 12 (1999).⁶ Information used to develop the ODF Debris Flow maps include:

- Digital elevation models at 30-meter resolution, based on U.S. Geological Survey data, were used to derive slope steepness and then to develop polygons for assigned hazards. Note that actual slopes are steeper than these digitally elevated models.
- Mapped locations of Tye soil formation and similar sedimentary geologic units.
- Oregon Department of Forestry Storm Impacts and Landslides of 1996 study; debris flow initiation and path location data.
- Stream channel confinement near steep hill slopes based on U.S. Geological Survey Digital Raster Graphics.
- Historical information on debris flow occurrence in western Oregon (from Oregon Dept. of Forestry, U.S. Forest Service, DOGAMI, Bureau of Land Management, and the Oregon Department of Transportation).
- Fan-shaped land formations below long, steep slopes.
- Areas of highest intensity precipitation do not appear to be correlated with known areas of high and extreme debris flow hazard, so precipitation intensity was not used to develop risk (hazard) ratings.⁷

Oregon Department of Geology and Mineral Industries (DOGAMI)

The Oregon Department of Geology and Mineral Industries (DOGAMI) conducted field investigations and consolidated data on Oregon landslides associated with three flood events in 1996 and 1997. They collected evidence of over 9,000 landslide and slope failure locations in the state. The generation of a statewide landslide inventory is intended to provide a means for developing and verifying hazard models as well as to facilitate various local efforts aimed at minimizing risk and damage in future storm events. The database includes a digital Geographic Information System file with landslide locations, a digital database with details on each landslide, and an accompanying report.⁸

In addition to the slope failures report, DOGAMI is identifying and mapping further review areas. The further review areas identify where landslides have occurred and where landslides are likely to occur.⁹

⁶ Western Oregon Debris Flow Hazard Maps: Methodology and Guidance for Map Use. (1999).

⁷ Ibid.

⁸ Database of Slope Failures in Oregon for Three 1996/1997 Storm Events. Hofmeister, R.J. (2000). Oregon Department of Geology and Mineral Industries – Special Paper 34.

⁹ Interagency Hazard Mitigation Team. 2012. Oregon Natural Hazards Mitigation Plan. Salem, OR: Oregon Military Department – Office of Emergency Management

Debris Flow Warning System

The debris flow warning system was initiated in 1997 and involves collaboration between the Department of Forestry, DOGAMI, the Department of Transportation, local law enforcement, and National Oceanic and Atmospheric Administration (NOAA) Weather Radio and other media.

Since 2008, ODF meteorologists have not issued Debris Flow Warning for Oregon since they do not have sufficient resources. However, information is provided by the National Weather Service (NWS) and broadcast via the NOAA Weather Radio, and on the Law Enforcement Data System. The information provided does not include the Debris Flow Warning system as originally designed since the NWS does not have the geologic and geomorphology expertise. Instead they provide the following language in their flood watches that highlights the potential for landslides and debris flows¹⁰:

A flood watch means there is a potential for flooding based on current forecasts. Landslides and debris flows are possible during this flood event. People, structures and roads located below steep slopes, in canyons and near the mouths of canyons may be at serious risk from rapidly moving landslides.

DOGAMI provides additional information on debris flows through the media. The Department of Transportation provides warning signs to motorists in landslide prone areas during high-risk periods.¹¹

Landslide Brochure

The Department of Geology and Mineral Industries (DOGAMI) developed a landslide public outreach brochure in cooperation with several other state agencies. Forty thousand copies were printed in November 1997 and were distributed widely through building code officials, county planners, local emergency managers, natural resource agency field offices, banks, real estate companies, insurance companies, and other outlets. Landslide brochures are available from DOGAMI, the Office of Emergency Management (OEM), Oregon Department of Forestry (ODF), and the Department of Land Conservation and Development (DLCD).¹²

Oregon State Building Code Standards

The Oregon Building Codes Division adopts statewide standards for building construction that are administered by the state and local municipalities throughout Oregon. The One- and Two-Family Dwelling Code and the Structural Specialty Code contain provisions for lot grading and site preparation for the construction of building foundations.

Both codes contain requirements for cut, fill and sloping of the lot in relationship to the location of the foundation. There are also building setback requirements from the top and bottom of slopes. The codes specify foundation design requirements to accommodate the type of soils, the soil bearing pressure, and the compaction and lateral loads from soil and ground water on sloped lots. The building official has the authority to require a soils analysis for any project

¹⁰ NOAA, NWS. Letter dated December 20, 2010 from Stephen K. Todd, Meteorologist-in-Charge.

¹¹ Interagency Hazard Mitigation Team. 2012. Oregon Natural Hazards Mitigation Plan. Salem, OR: Oregon Military Department – Office of Emergency Management

¹² Ibid.

where it appears the site conditions do not meet the requirements of the code, or that special design considerations must be taken. ORS 455.447 and the Structural Code require a seismic site hazard report for projects that include essential facilities such as hospitals, fire and police stations and emergency response facilities, and special occupancy structures, such as large schools and prisons. This report includes consideration of any potentially unstable soils and landslides.¹³

Hazard Mitigation Action Items

There are no identified Landslide action items for Deschutes County; however, several of the Multi-Hazard action items affect the Landslide hazard. An action item matrix is provided within Volume I, Section 3, while action item forms are provided within Volume IV, Appendix A. To view city actions see the appropriate city addendum within Volume III.

¹³ Planning for Natural Hazards: Oregon Technical Resource Guide. Community Planning Workshop. (July 2000). Chapter 5.

Significant Changes since the 2015 Plan

New information on the hazard and hazard identification was added to this section. As such, some sections utilize modified text from the Central Cascades Volcano Coordination Plan, particularly Appendix B: Volcanic Hazards in the Central Cascades. In addition, the format of the section and minor content changes has occurred.

Causes and Characteristics of Volcanic Eruption

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

The primary threat to lives and property from active volcanoes is from violent eruptions that unleash tremendous blast forces, generate landslides 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 volcano. The following section outlines the specific hazards posed by volcanoes.

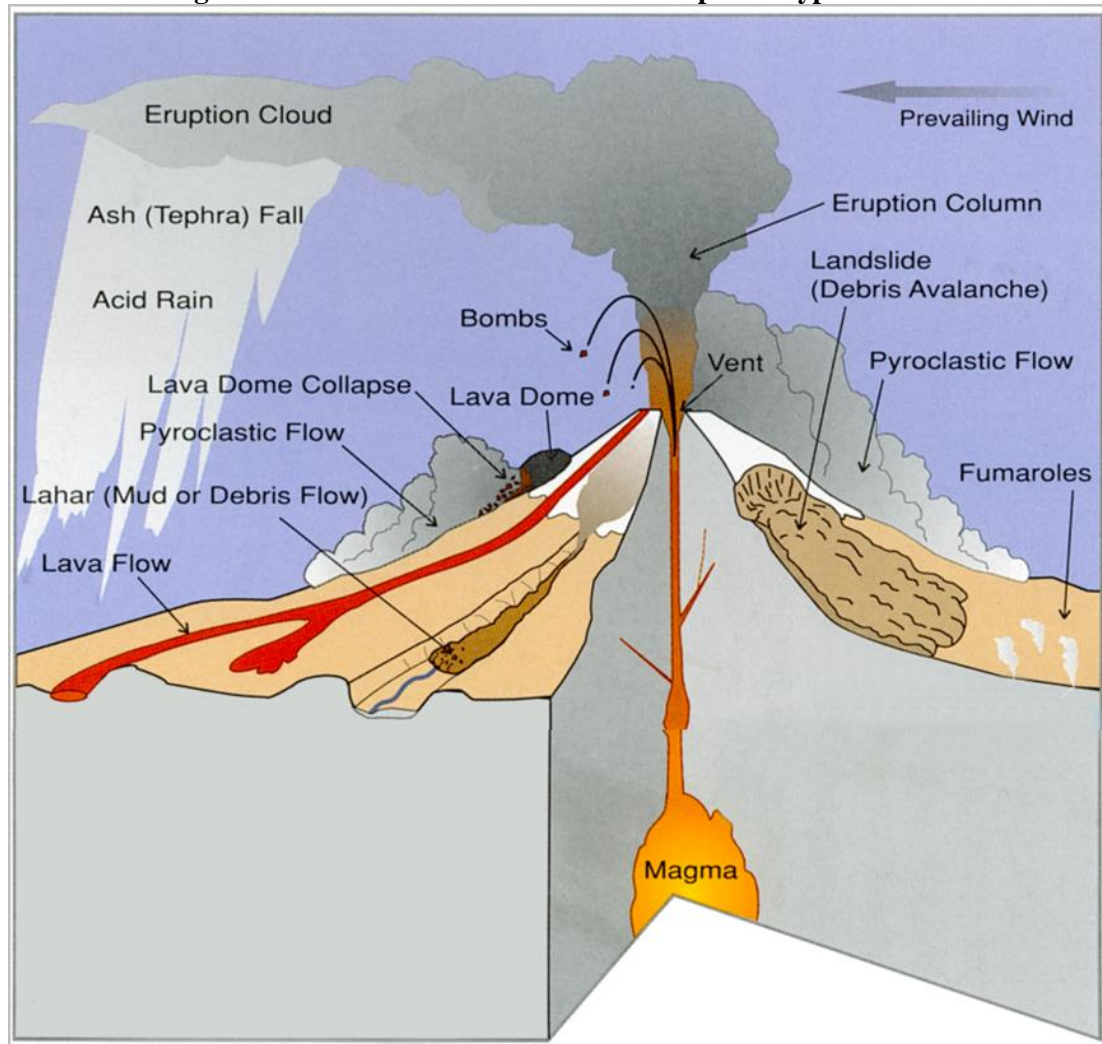
Volcanoes are commonly, but not always, conical hills or mountains built around a vent that connects with reservoirs of molten rock below the surface of the earth.¹ Volcanoes are built up by an accumulation of their own eruptive products: lava ash flows, debris flows, airborne ash and rocks, and lava domes. When pressure from gases or molten rock becomes strong enough to cause an upsurge, eruptions occur. Gases and rocks are pushed through and ejected from a vent. This intrusion of molten material can weaken volcanoes and trigger large landslides and violent blasts, thrust from a volcano in high eruption plumes, gush from a vent forming lava flows, or ooze from a vent in relatively calm manner and form a lava dome. Collapses of tall eruption plumes or lava domes can generate flows of hot gas, ash, and rock particles that rush down flanks of volcanoes (pyroclastic flows). Debris flows (lahars) can form when snow is melted on volcano flanks, when heavy rains fall on layers of volcanic ashfall, or when dammed lakes along valley margins breach.²³

¹ Tilling, Robert I., *Volcanoes*, USGS General Interest Publication, (1985).

² Myers, Brantley, Stauffer, and Hendley II., *What are Volcano Hazards?*, USGS Reducing the Risk from Volcano Hazards (Revised 2008). <https://pubs.usgs.gov/fs/fs002-97/>

³ Dzurisin, Stauffer, and Hendley II., *Living with Volcanic Risk in the Cascades*, USGS Reducing the Risk from Volcano Hazards (Revised 2008). <https://pubs.usgs.gov/fs/1997/fs165-97/>

Figure II-10 Volcanic Hazard from a Composite Type Volcano



Source: Walder et al, "Volcano Hazards in the Mount Jefferson Region," 1999; W.E. Scott, R.M. Iverson, S.P. Schilling, and B.J. Fischer, Volcano Hazards in the Three Sisters Region, Oregon: U.S. Geological Survey Open-File Report 99-437, 14p., 200.

Related Hazards

Ash / Tephra

Tephra fall is the rain of fragmented volcanic rock falling to the ground after being ejected from a volcano. It consists of volcanic ash (sand-sized or finer particles) and larger fragments. Larger fragments fall near the volcanic vent while finer (ash) particles drift downwind as part of a volcanic plume. When ash particles fall to the ground, they can form a blanket-like deposit, with finer grains carried further away from the volcano. In general, the thickness of tephra deposits decreases in the downwind direction. Depending on the size and energy of an eruption, tephra fall deposits can be tens of inches thick near volcanoes, and a few to many inches thick tens to hundreds of miles downwind. Tephra hazards include impact of falling fragments, respiratory problems, damage to crops and other vegetation, contamination of drinking water, roof

collapse, burial of transportation routes, damage to electrical grids, and mechanical or electrical failure of car and jet engines.

During an eruption that emits tephra, deposition is controlled by the prevailing wind direction.⁴ The predominant wind pattern over the Cascades is from the west; the geologic record shows the greatest number and thickest ash fall deposits are east of the volcanoes.⁵

Lava flows

Lava flows are streams of molten rock that erupt relatively non-explosively from a volcano and move downslope, sometimes at velocities of many miles per hour, causing extensive damage or total destruction by burning, crushing, or burying everything in their path. Secondary effects can include forest fires, flooding, and permanent reconfiguration of stream channels.⁶

Pyroclastic flows and surges

Pyroclastic flows are dense mixtures of hot ash, rocks, and gas at temperatures of 600 to 1500 degrees Fahrenheit that flow swiftly away from volcanoes. They typically sweep down the flanks of volcanoes at speeds of up to 150 miles per hour. Pyroclastic surges are a more dilute mixture of gas and ash. They can move even more rapidly than a pyroclastic flow and are more mobile. Both generally follow valleys, but surges sometimes have enough momentum to overtop hills or ridges in their paths. Because of their high speed, pyroclastic flows and surges are difficult or impossible to escape. If it is expected that they will occur, evacuation orders should be issued as soon as possible for the hazardous areas. Objects and structures in the path of a pyroclastic flow are generally destroyed or swept away by the impact of debris or by accompanying hurricane-force winds. Wood and other combustible materials are commonly burned. People and animals may also be burned or killed by inhaling hot ash and gases. The deposit that results from pyroclastic flows is a combination of rock and ash and is termed ignimbrite. If the deposit is sufficiently hot and sufficiently thick, it can consolidate and allow the granular particles to deform and merge together, forming a dense, coherent deposit called a welded tuff. Individual flow deposits can be a few to many feet thick, but multiple flows can form sequences of deposits that can accumulate to hundreds of feet thick and can harden to resistant rock.⁷

Lahars and debris flows

Lahar is an Indonesian term that describes a hot or cold mixture of water and rock fragments flowing down the slopes of a volcano or river valley.⁸ Small seasonal events are sometimes referred to as "debris flows", especially in the Cascades. Lahars can form when hot volcanic debris scours and melts snow and ice during eruptions of ice-clad volcanoes like South Sister, Mt. Hood, Mt. Rainier, or Mount Shasta. Heavy rains can also generate lahars by eroding tephra fall from slopes on and near volcanoes even after an eruption stops. Floods and lahars can be generated by the displacement of water from volcanic lakes, which can overtop dams and move

⁴ Oregon State Natural Hazard Mitigation Plan. 2012. "Volcanic Hazards Chapter," http://csc.uoregon.edu/opdr/sites/csc.uoregon.edu.opdr/files/docs/ORNHMP/OR-SNHMP_volcano_chapter.pdf

⁵ Ibid.

⁶ Oregon State Natural Hazard Mitigation Plan. 2012. "Volcanic Hazards Chapter," http://csc.uoregon.edu/opdr/sites/csc.uoregon.edu.opdr/files/docs/ORNHMP/OR-SNHMP_volcano_chapter.pdf

⁷ Ibid.

⁸ USGS website: <http://volcanoes.usgs.gov/Hazards/What/Lahars/lahars.html>

down outlet streams. Smaller seasonal debris flows can form by processes unassociated with a volcano or an eruption, such as during heavy rains following wildfires.

Some lahars begin as a landslide (debris avalanche) of wet, weakened rock on the steep flanks of volcanoes. These collapses and resultant lahars are natural events during a stratovolcano's life history and can occur long after it stops erupting.⁹ They can be triggered by instability at the onset of or during volcanic eruptions, large earthquakes, and intense ground deformation by rising magma and perhaps just long-term exposure to gravity.

Lahars and debris flows react much like flash flood events in that a rapidly moving mass travels downstream. As this flow moves downstream, it can ingest more sediment and debris as it scours out a channel. The flow can also incorporate water from rivers and by scouring snow and ice. By eroding rock debris and incorporating additional water, lahars and debris flows can grow to many times their initial size, but as they move farther away from the volcano they eventually lose sediment load and decrease in size.¹⁰

Lahars and debris flows often cause serious economic and environmental damage. Because they can transport boulders, logs, and other debris, they can easily crush, abrade, and destroy anything in the flow path. Even if not crushed or carried away by the force of the flow, buildings and valuable land may become partially or completely buried by one or more cement-like layers of rock debris. By destroying bridges and roads, lahars and debris flows can also trap people in areas vulnerable to other volcanic hazards, especially if the debris deposits are too deep, too soft, or too hot to cross.¹¹

Volcanic Landslides (debris avalanches)¹²

Landslides and debris avalanches are a rapid downhill movement of rocky material, trees, snow, and (or) ice. Volcanic landslides range in size from small movements of loose debris on the surface of a volcano to massive collapses of large segments of a volcano. Steep volcanoes are susceptible to landslides because they are built up partly of layers of loose volcanic rock fragments. Landslides on volcano slopes are triggered not only by eruptions, but also by heavy rainfall or large earthquakes that can cause materials to break free and move downhill.

Earthquakes

Earthquakes are another potentially hazardous event associated with volcanic eruptions. Volcanic earthquakes are commonly smaller than magnitude 2.5, roughly the threshold for felt shaking by observers close to the event. Swarms of small earthquakes may persist for weeks to months before eruptions, but little or no damage may occur to buildings in surrounding communities. Some swarms of volcanic earthquakes can include earthquakes as large as about magnitude 5. For the communities of Bend, La Pine, and Sunriver, shallow earthquakes in the magnitude 4-5 range that are located beneath Newberry Volcano or in the Three Sisters area would likely cause walls to rattle or windows and dishes to vibrate.

⁹ USGS, Volcanic Hazards Program. "Lahars move rapidly down valleys like rivers of concrete".

<https://www.usgs.gov/natural-hazards/volcano-hazards/lahars-move-rapidly-down-valleys-rivers-concrete>

¹⁰ Ibid.

¹¹ Ibid.

¹² Wright and Pierson, Living With Volcanoes, USGS Volcano Hazards Program Circular 1973, (1992).

History of Volcanic Events in Deschutes County

No eruptions have occurred in Deschutes County during the past 1,000 years; however the millennium before experienced numerous eruptions, including several at Three Sisters and one at Newberry Volcano. The most devastating effects of these events were restricted to what is now Wilderness or largely undeveloped areas, but tephra fall from these eruptions probably deposited less than one-quarter inch to one-half inch of gritty ash in areas that are now densely populated.

Although there have been no recent volcanic events in the Deschutes County area, it is important to note the area is active and susceptible to eruptive events since the region is a part of the active Cascade Volcanic Range. The figure below displays volcanoes of the western United States.

Figure II-11 Potentially Active Volcanoes of the Western United States



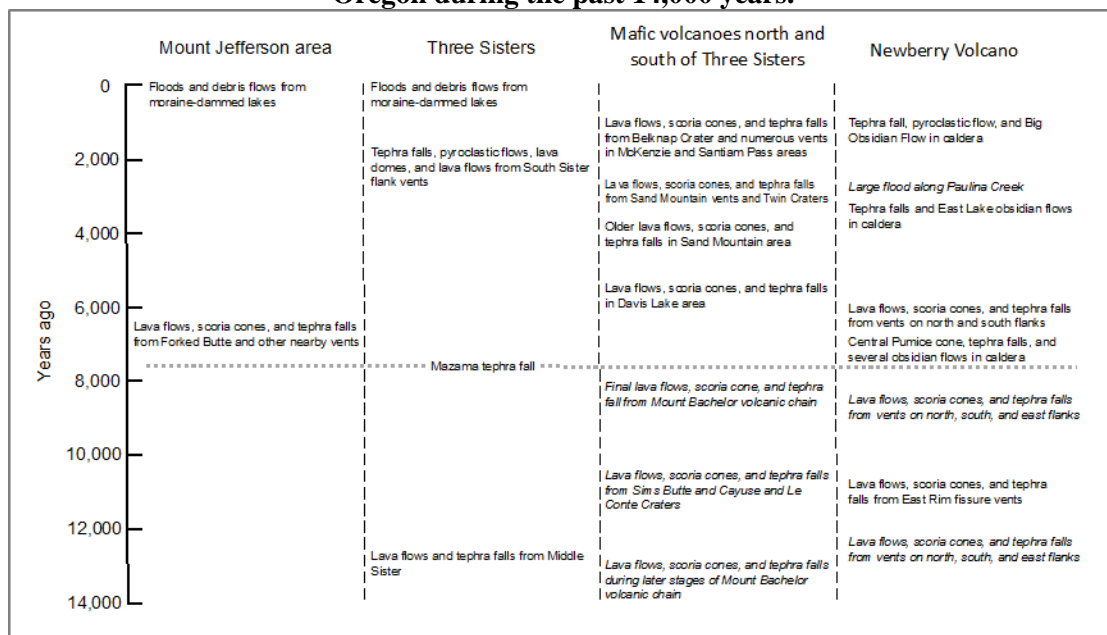
Source: USGS. <http://www.volcano.si.edu/reports/usgs/maps.cfm#usa>

Volcanoes in Central Oregon have been erupting for hundreds of thousands of years. Newberry Volcano, for example, has had many eruptions in the last 15,000 years as shown in the table below. The Three Sisters region has also had eruptions during this time, and the last major

eruptive activity at Mt. Mazama occurred approximately 7,700 years ago, forming Crater Lake. Some of the most recent events include tephra and lava from the Big Obsidian Flow eruption at Newberry Volcano, multiple eruptions of tephra and lava from South Sister, and multiple cinder cone eruptions and lava flows in the McKenzie Pass area. All of the Cascade volcanoes are characterized by long periods of quiescence and intermittent activity. These characteristics make predictions, recurrence intervals, and probability of future eruptions very difficult to ascertain.

Much larger eruptions than those of the past few thousand years have occurred in the region in recent geologic time, but, although their hazards are potentially much more widespread and severe, they occur much less frequently than smaller eruptions. Such potential hazards include extensive lava flows from Newberry Volcano that pose a threat to Bend and Redmond, large-scale explosive eruptions of Newberry or the Three Sisters that deposit one foot or more of pumice and ash in developed areas; or eruptions in the Three Sisters region that swiftly melt significant quantities of snow and ice to generate lahars that affect areas such as Whychus Creek and the City of Sisters.

Figure II-12 Eruptive and major debris-flow and flood events in the central Cascades of Oregon during the past 14,000 years.



Source: Central Cascades Volcano Coordination Plan. The events printed in italics are poorly dated, so their ages are less well known than those in normal font. The Mazama tephra fall was produced by the cataclysmic eruption of Mount Mazama that created Crater Lake 7,700 years ago.

Active volcanic areas in the Cascades that have the most potential to impact Deschutes County and the broader region include Mt. Saint Helens, Mt. Hood, Newberry Volcano, Mt. Bachelor, the Three Sisters and Broken Top, and Mt. Mazama/Crater Lake.

Table II-6 Regional Volcanic History

Volcano	Comment
Mount Saint Helens	Mount St. Helens, located in southwestern Washington. It is fifty thousand years old. Over the past 521 years it has produced four major explosive eruptions and dozens of smaller eruptions. On May 18th, 1980, Mount St. Helens exploded violently after two months of intense earthquake activity and intermittent, relatively weak eruptions, causing the worst volcanic disaster in the recorded history of the United States. Mount St. Helens continued to be active, on March 8, 2005, a plume of ash and steam spewed nearly seven miles high into the air. Ten small earthquakes were measured in the area leading up to the eruption. The largest appeared to be a magnitude 2.5, according to the USGS.
Three Sisters & Broken Top	The Three Sisters are located just west of Bend. South Sister had a very small ongoing uplift, which began in 1996 and became undetectable by 2003. This uplift was about one inch a year and likely indicated movement of a small amount of magma. There is no immediate danger of a volcanic eruption or other hazardous activity. The potential exists, however, that further activity could increase danger.
Newberry Volcano	Newberry Volcano is located east of the Cascade Range and about 20 miles south of Bend. It is about 400,000 years old and has had thousands of eruptions both from the central vent area and along its flanks. The most recent eruption was 1,300 years ago. Future eruptions are likely to include lava flows, pyroclastic flows, lahars, and ashfall. Most effects from these activities would be felt within, or up to a few miles beyond, the existing caldera. Ash and lava flows could impact tens of miles from the eruptive center.
Mount Mazama/ Crater Lake	Crater Lake is located in the south-central region of Oregon. About 7,700 years ago, the ancient Mount Mazama erupted with great violence, leaving the caldera that Crater Lake now occupies. The most recent volcanic eruption was about 5,000 years ago and occurred within the caldera. No eruptions have occurred outside the caldera since 10,000 years ago. The probability of another caldera-forming eruption is very low, as is the probability of eruptions occurring outside the caldera.

Source: Oregon Natural Hazards Mitigation Plan (2012); 2018 Update to the U.S. Geological Survey National Volcanic Threat Assessment <https://pubs.usgs.gov/sir/2018/5140/sir20185140.pdf>

Mount St. Helens Case Study

On May 18, 1980, following two months of earthquakes, deformation of the volcano, and minor eruptions and following a century of dormancy, Mount St. Helens, Washington, exploded in one of the most devastating volcanic eruptions of the 20th century. Approximately 0.67 cubic miles of volume was removed from the volcano in a huge debris avalanche (lowering the mountain summit elevation by 1,314 feet), 57 people died, lahars damaged 27 bridges and nearly 200 homes, 4 billion board feet of timber was blown down, and damage exceeded 1.2 billion

dollars.¹³ Fortunately, most people in the area had been evacuated before the eruption because the U.S. Geological Survey (USGS) and other scientists had alerted public officials to the danger. As early as 1975, USGS researchers had warned that Mount St. Helens could soon erupt. Coming more than 60 years after the last major eruption in the Cascades (Lassen Peak, 1915), the explosion of St. Helens was a spectacular reminder that the millions of residents of the Pacific Northwest share the region with live volcanoes.¹⁴

Hazard Identification

Western Deschutes County is on the east slope of the Cascade Range. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when, remain. Many volcano-associated hazards affect local areas within 5 to 10 miles (e.g., explosions, lava flows, pyroclastic flows and debris avalanches). However, lahars, or volcanic mudflows can travel considerable distances down river valleys and wind-borne tephra (ash) can blanket areas many miles from the source.

Deschutes County is therefore at risk from volcanic events and should consider the impact of volcano-related activity on communities, dams that create reservoirs, tourist destinations (e.g., Sunriver, Mt. Bachelor, and Crater Lake), agriculture, public health, highways and railroads. Deschutes County should also consider probable impacts on the local economy should a volcano-related hazard occur.

Two long-lived volcanic centers, Three Sisters to the west and Newberry Volcano to the south, and many tens of smaller volcanoes have hosted numerous eruptions in geologically recent times that range widely in size and character. Some covered sizable, currently developed areas with lava flows or swiftly moving flows of searing ash and pumice. Others only managed to produce small volumes of ash that blew downwind and were barely detectable in the geologic record, or they produced lava flows in areas now protected as Wilderness. Similar eruptions will occur in the future and, depending on their location and scale, will have minor to catastrophic effects on the County. In fact, the Three Sisters and Newberry Volcano are ranked by the USGS as “very high threat” volcanoes and are among the top 20 most hazardous volcanoes in the U.S.¹⁵ In addition, an eruption of any one of the major Cascade volcanoes could affect the county and the region with ashfall if the wind direction is favorable.

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

¹³ Brantley, Steve and Bobbie Myers. Mount St. Helens – From the 1980 Eruption to 2000. USGS Fact Sheet 036-00 Online Version 1.0. <http://pubs.usgs.gov/fs/2000/fs036-00/>

¹⁴ Dzurisin, Dan, Peter H. Stauffer, and James W. Hendley II, Living With Volcanic Risk in the Cascades, USGS Fact Sheet 165-97, (2000).

¹⁵ 2018 Update to the U.S. Geological Survey National Volcanic Threat Assessment <https://pubs.usgs.gov/sir/2018/5140/sir20185140.pdf>

Figure II-13 Volcanic Hazards in Central Oregon

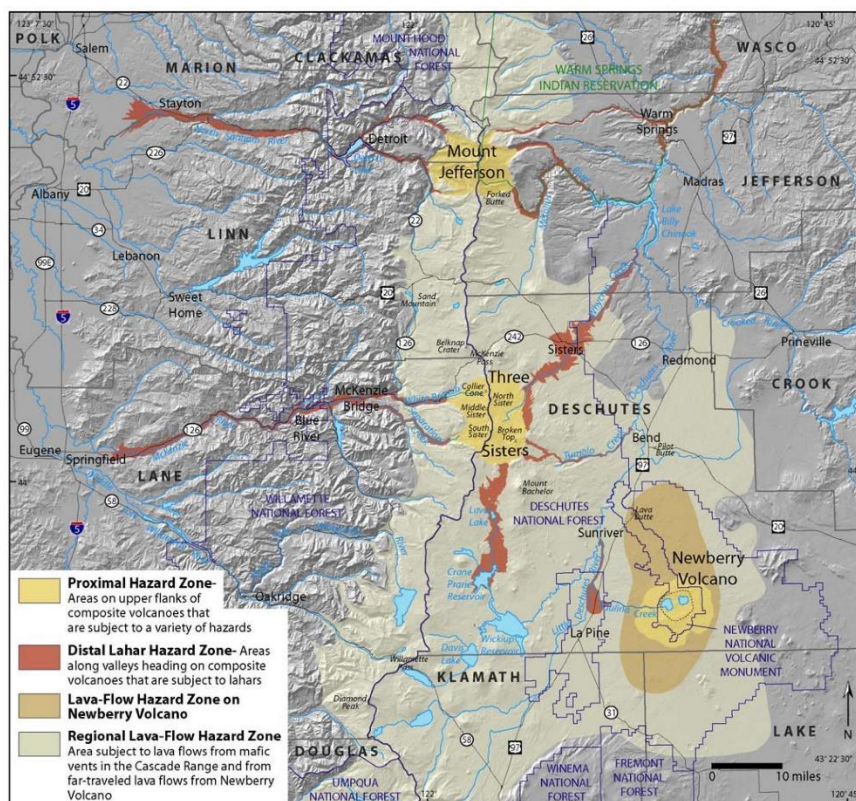


Figure 2. **Volcano hazards in central Oregon.** Hazard zones are modified from the USGS hazard assessments for Mount Jefferson, Three Sisters, and Newberry Volcano listed in references.

Source: Central Cascades Volcano Coordination Plan

Multiple hazards zones affect Deschutes County (Figure 2). Although the hazard map shows sharp boundaries for hazard zones, the degree of hazard does not change abruptly at these boundaries. Rather, the hazard decreases gradually as distance from the volcano increases, and decreases more rapidly as elevation above valley floors increases. Areas immediately beyond outer hazard zones should not be regarded as hazard free, because the boundaries can only be located approximately, especially in areas of low relief. Too many uncertainties exist about the source, size, and mobility of future events to locate the boundaries of zero-hazard zones precisely. Additionally, tephra (ash) hazard zones are not shown on the map, but tephra can impact large areas and the entire map region should be regarded as within the tephra hazard zone.

The **proximal hazard zone** includes areas immediately surrounding the volcanoes. This zone, which extends outward from summits for as little as 2 to as many as 10 kilometers (six miles) depending on local topography, is subject to several types of rapidly moving, devastating flows including pyroclastic flows, debris avalanches, lahars, and dam-break floods. Slower moving lava flows could also affect these zones.¹⁶

The **distal hazard zone** lies beyond the proximal hazard zone and is concentrated in the surrounding valleys that head on the volcanoes. Debris avalanches and lahars will tend to funnel

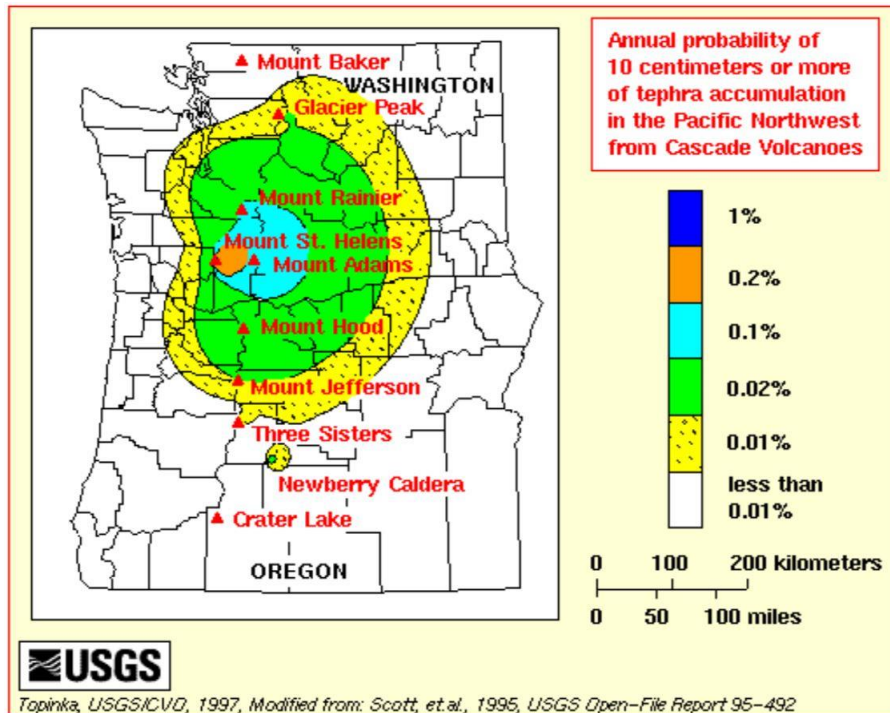
¹⁶ Scott, W.E., Iverson, R.M., Schilling, S.P., and Fisher, B.J., 1999, Volcano hazards in the Three Sisters region, Oregon: U.S. Geological Survey Open-File Report 99-437.

into these valleys as they leave the slopes of the large volcanoes within the proximal hazard zone.

The **regional lava-flow hazard zone** outlines the area of the Three Sisters and Newberry Volcano region subject to lava flows from eruptions of mafic volcanoes. The zone is defined by the distribution of mafic volcanoes that erupted during roughly the past one million years. Hazards from thick tephra fall, ballistic projectiles, and small to medium pyroclastic flows would be restricted to within several kilometers of vents, but lava flows could travel much farther. The hazard zone covers a broad area in Central Oregon, including Bend, Sisters, and areas on the lower flanks of Newberry Volcano in La Pine.

Distributions of volcanic ash fall are affected by wind direction. Scientists also use wind direction to predict areas that might be affected by volcanic ash; during an eruption that emits ash, the ash fall deposition is controlled by the prevailing wind direction. The predominant wind pattern over the 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 II-14 depicts the potential and geographical extent of volcanic ash fall in excess of ten centimeters from a large eruption of Mount St. Helens.

Figure II-14 Regional Tephra-fall Maps



Note: The following sections include information that has been modified from the Central Cascades Volcano Coordination Plan, Appendix B: Volcanic Hazards in the Central Cascades.

Three Sisters Volcanoes

Large snow-covered volcanoes of the Three Sisters volcanic center dominate Central Oregon's landscape between Santiam Pass in the north and Willamette Pass in the south. Rapidly developing areas in Deschutes County occupy the eastern border of the region, and westward several small communities dot the McKenzie River valley along its course to the Eugene-Springfield metropolitan area.¹⁷

The following photograph depicts an aerial view from southeast of the Three Sisters volcanic center (South, Middle, and North Sister left of center; Broken Top right of center). Light colored areas on the south flank of South Sister are 2,000-year-old lava flows.

Figure II-15 Three Sisters and Broken Top

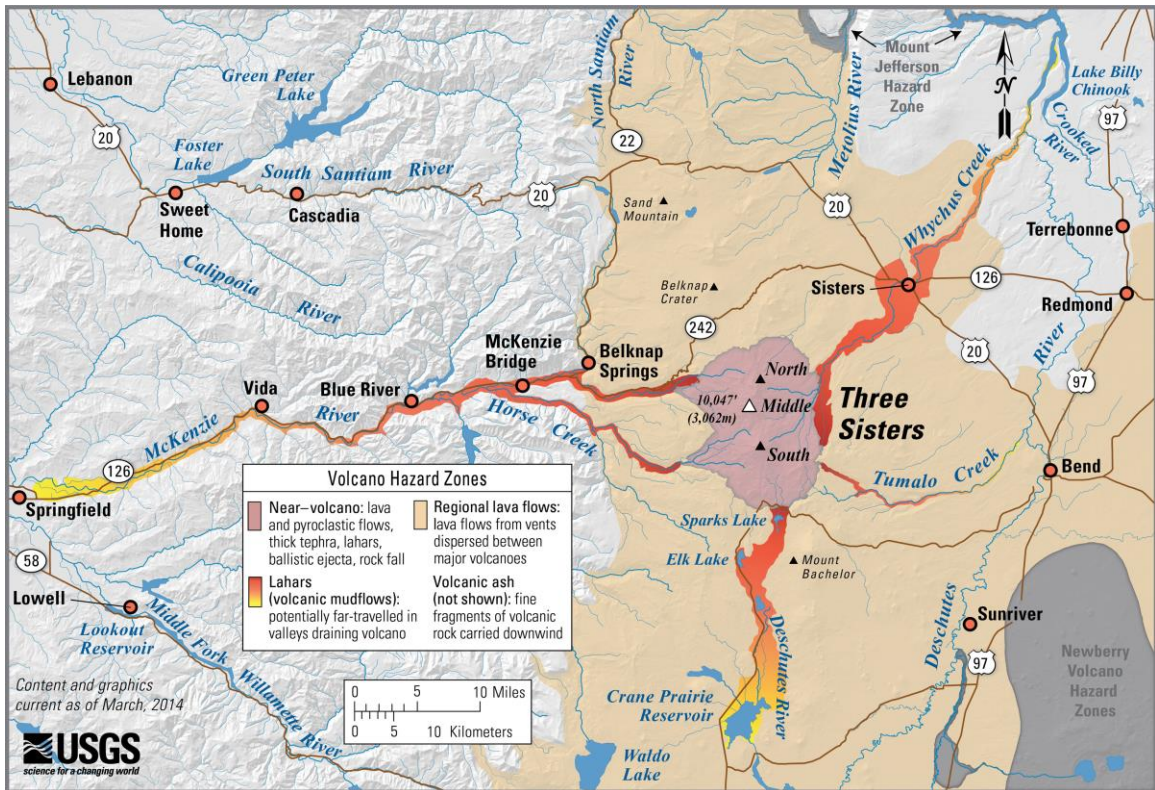


Photo by William E. Scott, USGS

Unlike other major Cascade volcanic centers, the Three Sisters center contains two young composite volcanoes, South Sister and Middle Sister, rather than one. The third sister, North Sister, and other nearby conspicuous volcanoes such as Mount Bachelor are large mafic volcanoes. Broken Top is a composite volcano that has not erupted for tens of thousands of years. Eruptions about 2,000 years ago from vents on South Sister produced blocky lava flows, such as Rock Mesa. These eruptions also produced a modest amount of pumice and ash that blanketed downwind areas. Probably no more than 1 or 2 centimeters (less than one inch) of ash fell in the area now occupied by Bend. Similar, but larger, eruptions occurred during the last ice age, which ended about 12,000 years ago, and had more widespread effects. Such eruptions occurred from both Middle Sister and South Sister. Three eruptions during the past one-half million years have been significantly larger and produced pyroclastic flows that swept over present-day Bend and Sisters. Fortunately such eruptions are rare—the last one occurred more than 200,000 years ago—and there is no sign that the Three Sisters system is capable of producing such an eruption during our lifetimes. The figure below demonstrates the volcanic hazards associated with the Three Sisters.

¹⁷ Ibid.

Figure II-16 Volcanic Hazards of the Three Sisters



Source: Central Cascades Volcano Coordination Plan. Hazard zones are simplified from the USGS hazard assessment for the Three Sisters volcanic area. Tephra (ash) hazard zones are not shown, but tephra can impact large areas and the entire map region should be regarded as within the tephra hazard zone.

Owing to the prevailing westerly winds in central Oregon, areas east of the Three Sisters have the greatest probability of being affected by tephra falls from future eruptions. Eruptions that produce higher eruption clouds and greater volumes of tephra will affect progressively larger areas. Although seldom life threatening, ash fall can greatly disrupt life. Darkness and swirling clouds of ash limit visibility and affect transportation. Ash contributes to slippery conditions on wet roads. Ash is also electrically conductive, especially if wet, and abrasive, so it can severely affect electrical and mechanical systems. Ash is also extremely dangerous to aircraft in flight. Very fine ash fall can also affect those with respiratory challenges if inhaled.

Eruptions that disrupt watersheds by removing vegetation and adding large quantities of sediment from tephra fall, pyroclastic flows, debris avalanches, and lahars, typically initiate a period of years to decades during which streams carry increased sediment loads and channels become unstable and migrate. Such effects propagate downstream and can disrupt channels and floodplains far from where direct impacts of eruptions end. The Eugene-Springfield area along the lower McKenzie River and Sunriver and Bend along the Deschutes River below Wickiup Reservoir could be vulnerable to such events in the years following eruptions. Similarly the Tumalo Creek watershed that supplies part of Bend’s municipal water, although not likely to be affected directly by volcanic flows, is likely to receive ash fall from any eruption in the Three Sisters area.

South, Middle, and North Sister as well as Broken Top are high, steep-sided peaks that could also produce debris flows and avalanches without volcanic activity. Avalanches of modest volume (less than about 10 million cubic meters) are the most probable and would affect areas primarily within the proximal hazard zone. Nevertheless, even modest-sized avalanches that contain sufficient water could transform into debris flows that travel well into distal hazard zones. Very large avalanches, those involving hundreds of millions of cubic meters of rock debris would likely be preceded by pronounced volcano deformation driven by intrusion of magma. Such activity would be detectable by seismometers and volcano surveys, and thus would elicit advance warning. Drainage systems that originate in the Three Sisters area are all potentially at risk from lahars, debris flows, floods, and avalanches. The location and size of these events will depend on the triggering mechanism and its character.

- Separation Creek and White Branch lead to several small communities in the McKenzie valley, including McKenzie Bridge and Blue River, which could be in the paths of lahars flowing westward. Large-volume lahars could reach communities farther west. Oregon Highway 126 and municipal water and hydroelectric facilities could be affected by lahars and excess sediment in the McKenzie River.
- The Sisters area represents the largest concentration of residents and development in a lahar-hazard zone. The city lies less than 30 kilometers (19 miles) downstream from Middle and South Sisters along Whychus Creek. Below Sisters, Whychus Creek flows into a deep canyon and joins the Deschutes River. Whychus Creek and its tributaries drain the east flanks of North, Middle, and South Sister and the north flank of Broken Top. The broad fan of Whychus Creek around Sisters is of particular concern with regard to potential lahar or debris flow inundation because Whychus Creek drains a large sector of the major volcanoes and the distance to Sisters is relatively short (about 30 kilometers or 20 miles). Typical flow velocities for lahars and debris flows through terrain along Whychus Creek yield travel times to Sisters of as little as 30 minutes to one hour, depending on lahar size and point of origin.
- Tumalo Creek drains the area east of Broken Top and is unlikely to experience large lahars owing to lack of much volcano mass in its headwaters. Nevertheless, small lahars or debris flows might descend Tumalo Creek if rapid sedimentation in Crater Creek diverted debris over a low divide into Tumalo Creek.
- Carver Lake, located 7,800 feet elevation on the east flank of South Sister in the Three Sisters Wilderness, is a glacial moraine-dammed lake. The lake formed when Prouty Glacier retreated from the terminal moraine circa 1930. Lake volume is estimated to be 740 acre-feet with a depth of more than 100 feet. Carver Lake is part of the headwaters of Whychus Creek which flows 20 miles to Sisters, Oregon. Historically, some moraine dams have failed causing a breach and flooding the channel. Failure of the moraine could come from an earthquake, volcanic eruption, or a large wave from the calving of the glacier. Recent two-dimensional (2-D) numerical modeling shows that a displacement and breaching of Carver Lake would produce a flood and debris flow downstream along Whychus Creek. The debris flow and flood were primarily confined to the Whychus Creek drainage for an approximately 15 km reach downstream of Carver Lake, where the creek is deeply incised for much of its path. Several kilometers upstream of the community of Sisters, Whychus Creek opens onto an alluvial fan with low relief and a system of (now dry) distributary channels. When the modeled flow reached this fan after about 1 hour, it immediately overtopped the low banks of the main branch of Whychus Creek, spreading into the distributary channels. The flow

continued to spread widely across the alluvial fan, eventually inundating Sisters. However, due to the spreading, the depth of the flow in the main channel was reduced significantly, presumably lessening the flood risk posed to the more densely populated area of Sisters adjacent to the main channel. These new results contrast with early 1-D simulations performed in the 1980's, which assumed that most of the flow was confined to the channel. These new results suggest that flow avulsion and diversion on the alluvial fan surrounding Sisters would lead to a less severe flood hazard to the community. The probability of Carver Lake moraine dam failing is low. This dam failed in October of 1966, generating a debris flow that traveled down the Soda Creek drainage, across Highway 46 (Cascade Lakes Highway), and spread out over the broad meadow near Sparks Lake. The debris flow buried the road and covered about 250,000 m² (about 2,700,000 ft²) of the meadow with sand and silt.¹⁸¹⁹

- Broad basins in the upper Deschutes valley, such as those occupied by Sparks, Elk, and Lava lakes, provide traps for lahars and sediment moving south, as do Wickiup and Crane Prairie Reservoirs.

Newberry Volcano

Overview—Newberry Volcano is among the largest and most voluminous of Cascade volcanoes. Although it is not of great height, it is very broad. Newberry lavas extend about 120 kilometers (75 miles) north to south and 43 kilometers (27 miles) east to west. The edifice covers more than 3,000 square kilometers (1,200 square miles), making it by area the largest volcano of the Cascades volcanic chain. Beyond the edifice, Newberry lava flows cover an additional 700 square kilometers (270 square miles), and reach about 25 kilometers (16 miles) north of Redmond. Hundreds of volcanic vents exist on the flanks of Newberry, many arranged in linear arrays, or rift zones, that extend far down the flanks. The youngest rift-zone eruption occurred about 7,000 years ago. At that time, a 32-kilometer long (20-mile long) fissure system opened extending northwest from the caldera. On this Northwest Rift Zone, lava fountains and small explosive eruptions created cinder cones, such as 150-meter high (500-foot high) Lava Butte, and wind spread blankets of cinders and ash downwind, often preceding lava flows. Lava flows from Lava Butte traveled more than 8 kilometers (5 miles) from the vent and temporarily dammed the Deschutes River.

Lava flows—Most of the City of Bend east of the Deschutes River is built on lava flows from Newberry Volcano. Potential future eruptions from rift zones on the north flank of Newberry represent the most credible lava-flow threat to a large settled area in the United States outside of Hawai'i. Lava flows advance relatively slowly compared to rapid flows such as lahars and pyroclastic flows, so they rarely threaten human life. But advancing lava flows ensure almost total destruction from burial and incineration. Lava flows can crush or bury structures, roads, railroads, power lines, gas lines, and other important infrastructure. They can also dam rivers and streams, causing floods and contamination of drinking water, and they can ignite fires. Once

¹⁸ O'Connor, J.E., J.H. Hardison and J.E. Costa. 2001. Debris flows from failures of Neoglacial-Age moraine dams in the Three Sisters and Mount Jefferson wilderness areas, Oregon. US Geological Survey Professional Paper 1606.

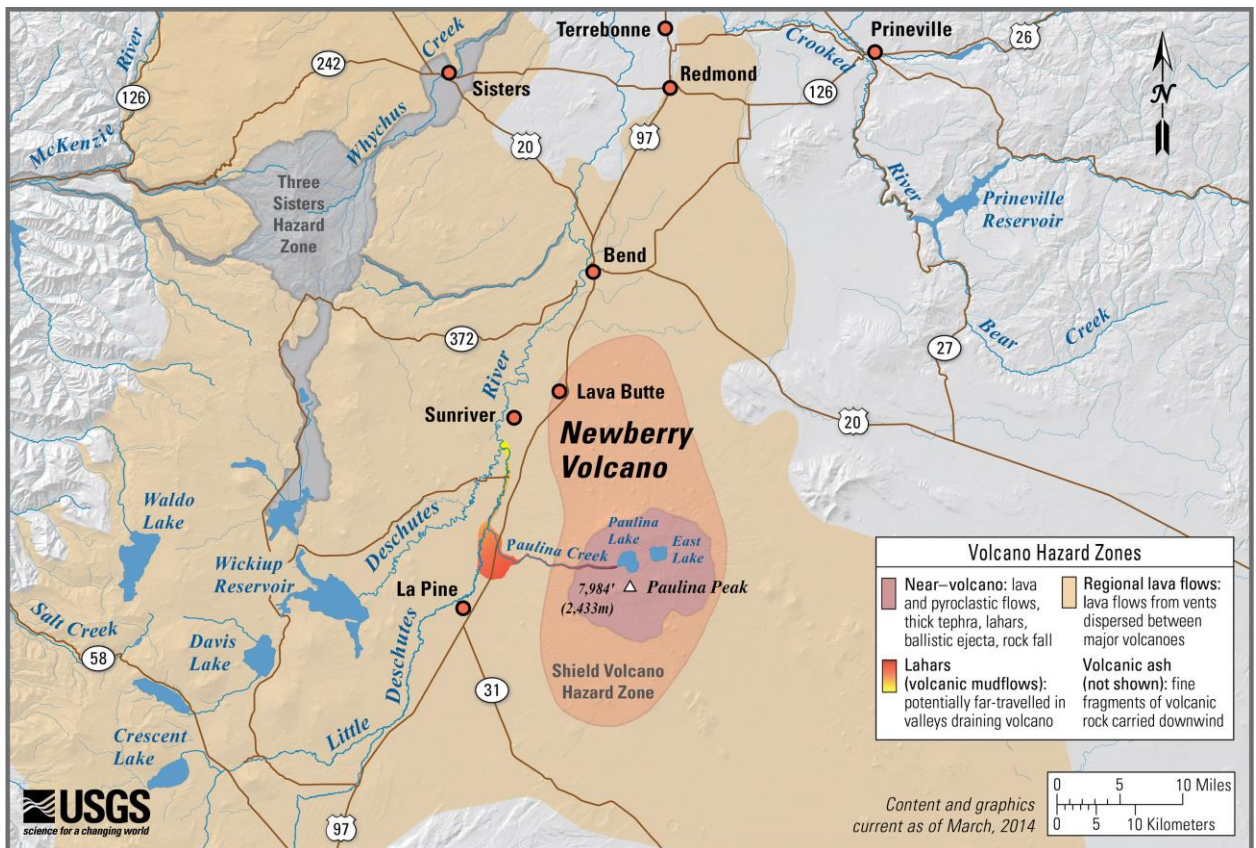
¹⁹ Laenen, Antonius, Scott, K M., Costa, J. E., and Orzol, L. L., 1987, HYDROLOGIC HAZARDS ALONG SQUAW CREEK FROM A HYPOTHETICAL FAILURE OF THE GLACIAL MORaine IMPOUNDING CARVER LAKE NEAR SISTERS, OREGON, Department of Interior, US Geological Survey, Open File Report 87-41

lava begins to flow from a vent, scientists are typically able to forecast which areas down slope are at greatest risk.

Explosive eruptions—Newberry has also produced notable explosive eruptions. Most of these originated from vents located in the broad depression, or caldera, that forms the summit of the volcano. The most recent eruption in the caldera occurred 1,300 years ago. It generated ash clouds that deposited tephra as far east as the Oregon-Idaho border, small pyroclastic flows, and lava of the Big Obsidian Flow. Larger events occurred in the more distant geologic past at Newberry, including some that transported tephra over broad areas of the western United States and sent pyroclastic flows down the volcano’s flanks.

During potential future explosive eruptions, cinder cone eruptions on the volcano’s flanks could generate modest amounts of tephra that would accumulate near the erupting vent. Explosive eruptions from Newberry caldera could send large amounts of ash several kilometers into the atmosphere where it could be blown by wind to populated regions and become a hazard to aviation. Close to the vents, the ash deposits could be several meters thick, but would typically thin quickly with distance from the vents.

Figure II-17 Volcanic Hazards of Newberry Volcano



Source: Central Cascades Volcano Coordination Plan. Hazard zones are simplified from the USGS hazard assessment for the Three Sisters volcanic area. Tephra (ash) hazard zones are not shown, but tephra can impact large areas and the entire map region should be regarded as within the tephra hazard zone.

Volcanic gases—The presence of the summit caldera and closed basins within it create conditions favorable for accumulation of heavier-than-air volcanic gases, notably carbon

dioxide, which could lead to dangerous conditions if increased emission of gas occurs during volcanic unrest or an eruption. Heavier-than-air gases could result in asphyxiation for anyone within the caldera. Other gases released by volcanic activity—such as SO₂ and H₂S—can also produce hazardous air quality in proximal areas.

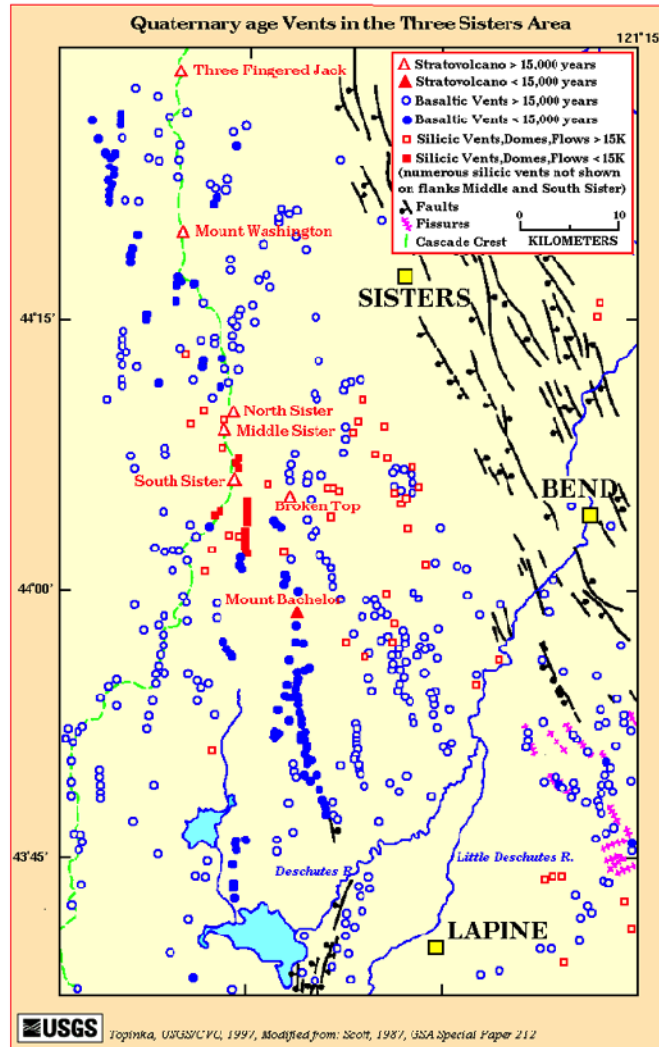
Geothermal—Several lines of evidence indicate that an active magma system exists beneath Newberry Volcano. Currently, both lakes within the caldera, Paulina and East Lake, contain hot springs with temperatures as high as 135 degrees F. A USGS drill hole made in 1981 found temperatures higher than 500-degrees at a depth of 3,000 feet. Several areas on the flanks of Newberry Volcano are being explored as potential sources for geothermal energy. High temperatures encountered now by hot spring users, and by geothermal drillers could become elevated during volcanic reawakening. Additionally, if a volcanic vent opened beneath the caldera lakes or through groundwater, the eruption would almost certainly be highly explosive and would deposit wet, muddy tephra over the immediate area.

Hydrologic hazards—As has happened in the past, rapid release of water from Paulina Lake or from rapid snowmelt could produce lahars, debris flows, or floods that descend Paulina Creek and inundate the Paulina Prairie area north of La Pine.

Fields of Mafic Volcanoes

Hundreds of geologically young volcanoes composed of cinders, ash, and lava flows dot the Central Oregon landscape among the major volcanic centers. Many, such as Collier Cone on the north flank of North Sister, occur on or near larger composite volcanoes; others occur many miles from larger volcanoes. Some of these, such as the Pilot Butte cinder cone in Bend, occur within densely populated areas. Some of these volcanoes are cinder cones (e.g. Collier Cone, Pilot Butte, Lava Butte); others, such as Mount Bachelor, are large shield volcanoes that stand more than 1,000 meters (3,300 feet) above their bases and can be more than 10 kilometers (6 miles) wide. The figure below shows how common these vents are in the Central Oregon landscape.

Figure II-18 Geologically Young Vents in the Three Sisters Area



Source: USGS. Blue circles show fields of mafic vents scattered throughout the Central Oregon Cascades. Solid circles indicate vents younger than 15,000 years, open circles indicate vents older than 15,000 years.

There are many young mafic volcanoes in the region, including Belknap Crater north of McKenzie Pass and Blue Lake Crater, which were active about 1,300 years ago. Geologic evidence suggests that the eruptions forming mafic volcanoes may have lasted for centuries in the case of the largest cones, to weeks to months for smaller ones. In some cases, vents in linear chains more than 10 kilometers (6 miles) were erupting concurrently, or nearly so. Since the last ice age waned, about 12,000 years ago, vents of mafic volcanoes have been concentrated in a narrow zone about 80 kilometers (50 miles) long, extending from south of Mount Bachelor to north of Santiam Junction. A few scattered vents in the area between Davis Lake and Oregon Highway 58 and a few south of Mount Jefferson were also active during this time period.

Future eruptions of mafic volcanoes are possible anywhere in the broad central Cascades region, although eruptions are probably more likely to occur in the greater Three Sisters area and on the flanks of Newberry Volcano, judging from the volcanic history of the past 14,000 years. Tephra from eruptions of mafic volcanoes will affect areas chiefly east of the Cascade crest.

Tephra falls from ongoing eruptions of mafic volcanoes could last months to years, or even longer, would be a chronic nuisance in Deschutes County. Once an eruption begins, the ultimate extent of lava flows will depend on vent location, local topography, and the total volume and rate of lava erupted, but scientists will be able to make forecasts about areas at greatest risk. Future lava-flow eruptions in the central Cascades are more likely to occur away from populated areas and are more likely to impact forests and stream channels, but could also impact major highways and power-line corridors.

Probability Assessment

The annual probability of volcanic activity in or affecting Deschutes County can only be estimated with great uncertainty, but, depending on the type of eruption, ranges from roughly 1 in 1,000 to 1 in 10,000. However, as precursors of volcanic unrest begin the probability of eruption increases greatly. The precursors might include increased seismic activity, temperature and chemical changes in groundwater, ground deformation and release of volcanic gases.

The average annual probability of future mafic eruptions is roughly 1 in 1,500. Because most recent activity has been concentrated in the area between the North Sister and Santiam Pass, future activity is probably more likely there than in other parts of the lava flow hazard zone to the south and east, which includes most of the settled areas in the region. Furthermore, because only a relatively small part of the entire lava flow hazard zone is affected during one eruptive episode, the annual probability of any given point in the hazard zone being affected is considerably less than the average annual probability of 1 in 1,500. The US Geological Survey estimates the range of annual probabilities falls between 1 in 10,000, for some areas near the Cascade Crest around Three Sisters and on the upper flanks of Newberry Volcano, to 1 in 1,000,000 elsewhere. Because ashfall from such eruptions covers much larger areas than lava flows, the probability of ashfall affecting an area is greater.

When a volcano erupts here again, areas close to the erupting vent will be severely affected. For the main Cascades peaks, a proximal hazard zone roughly 20 kilometers (12 miles) in diameter surrounding the volcano could be affected within minutes of the onset of eruption or large landslide. Distal hazard zones that follow river valleys downstream could be inundated by lahars or debris flows generated either by melting of snow and ice during eruption or by large landslides.²⁰

On the basis of no prior events in the past 10,000 years, it is estimated that a lahar voluminous enough to inundate the largest of the distal hazard zones in any valley has an annual probability of less than 1 in 10,000. A lahar voluminous enough to inundate the smallest of the distal hazard zones in any valley has a greater annual probability, perhaps from 1 in 1,000 to 1 in 10,000. Still smaller lahars or debris flows that result from phenomena such as moraine-dam failures are much more likely to occur (annual probability greater than 1 in 100 in potentially affected valleys), but are apt to inundate only parts of the smallest distal hazard zones immediately adjacent to streams.

Major drainage systems that head in the Three Sisters area (Separation Creek, White Branch, Whychus Creek, and Tumalo Creek) are all potentially at risk from lahars during future

²⁰ Ibid.

eruptions, or from debris flows and floods. The location and size of these events will depend on the site of the triggering mechanism and its character.

At least four times in the past 700,000 years, explosive eruptions that were probably sited east of the present location of Broken Top and the Three Sisters produced pyroclastic flows that swept over a broad area from Sisters to south of Bend. Such an event today would be catastrophic for Deschutes County, but fortunately, events of this magnitude are infrequent. Furthermore, there is no evidence that the large volume of magma necessary to drive such an eruption is present in the Three Sisters region today, nor would such a volume likely be generated in the near future.²¹

The annual probability of explosive eruptions at Newberry Volcano affecting the caldera and immediately adjacent areas is about 1 in 3,000 (four eruptive periods, one basaltic and three rhyolitic, in 12,000 years). The probability of such an eruption occurring in a 30-year period, the duration of many home mortgages or a human generation, is roughly 30 times the annual probability or 1 in 100.

The valley of Paulina Creek, which drains from Paulina Lake through the west rim of Newberry Caldera, is the most likely drainage on Newberry to carry damaging lahars and floods. In addition to lahars and floods caused by pyroclastic flows melting snow, a lahar could be generated along Paulina Creek by catastrophic lake overflow. Pyroclastic flows entering the lake or explosive eruptions in the lake itself could displace water into the Paulina Creek drainage. Lahars or floods from Paulina Lake could reach the La Pine valley within 30 minutes.²²

Where Paulina Creek leaves the confines of its canyon, it diminishes in gradient and forms a broad alluvial fan. Lahars could spread across Paulina Prairie and extend north along the floodplain of Paulina Creek to its confluence with the Little Deschutes River. The 100-year floodplain of the Little Deschutes River downstream from Paulina Creek is also included in the hazard zone for lahars and flooding in the event of volcanically induced surges of water from Paulina Lake.

The U.S. Geological Survey defines two lava flow hazard zones for Newberry on the basis of likelihood of future lava flows within each zone. Lava flow hazard zone LA encompasses the area more likely to be the site of flank vents or to be covered by lava, including the caldera. Zone LB includes two main areas: (1) areas on the lower flanks of Newberry that have relatively few flank vents and are chiefly covered by large lava flows from vents farther upslope and (2) lava flows from vents elsewhere in the Cascade Range or Basin and Range.

The outer boundary of lava flow hazard zone LA is determined by encircling the part of the volcano with greatest density of vents as determined by geologic mapping. As shown on the hazard map, the outline of zone LA broadly defines the elongate shape of Newberry Volcano itself, consistent with the idea that the volcano has grown by the repeated eruption of lava from vents preferentially located on the north and south flanks and in the summit region. The probability that a flank eruption will affect a given area in zone LA can be estimated only approximately because the frequency of such eruptions prior to the last ones about 7,000 years

²¹ Central Cascades Volcano Coordination Plan, 2007.

²² Scott, W.E., Iverson, R.M., Schilling, S.P., and Fisher, B.J., 1999, Volcano hazards in the Three Sisters region, Oregon: U.S. Geological Survey Open-File Report 99-437.

ago are poorly known. The U.S. Geological Survey infers that the annual probability of a flank eruption occurring in zone LA is roughly 1 in 5,000 to 1 in 10,000.

Lava flow hazard zone LB encompasses the entire hazard map area beyond zone LA. Zone LB includes areas on the lower flanks and down slope from Newberry Volcano and elsewhere in the region that have been affected by lava flows less frequently than areas in zone LA. The U.S. Geological Survey estimates that the annual probability of an eruption in this zone or of lava flows invading this zone from vents in zone LA is roughly 1 in 100,000, or less, on the basis of the frequency of lava flow coverage in the past one million years and the few, widely scattered vents in the region.

Deschutes County's Natural Hazards Mitigation Steering Committee believes that the County's **probability of experiencing a volcanic event is "low,"** meaning one incident is likely within the next 75 – 100 year period (or longer). Based upon available information the Oregon NHMPs Regional Risk Assessment rates Deschutes County's probability of a volcano event as "moderate".²³

Vulnerability Assessment

All of the Pacific Northwest is vulnerable to impacts from volcanic activity. Like the rest of Central Oregon, Deschutes County has some risk of being impacted by volcanic activity in the Cascade Range. Figure II-13 shows the identified hazard zones for volcanic activity.

The Deschutes County Natural Hazards Steering Committee rated Deschutes County as having a **"high" vulnerability to volcanic hazards;** meaning more than 10% of the region's population or assets would be affected by a major emergency or disaster. Based upon available information the Oregon NHMPs Regional Risk Assessment rates Deschutes County's vulnerability to a volcano event as "moderate".²⁴ However, the communities of Bend, La Pine, and Sisters may be at greater risk since they are located closer to the main volcanoes and are more at risk for inundation by lava and pyroclastic flows, lahars and debris flows, or ash fall.

Risk Analysis

The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section), and (2) the likelihood or probability of the harm occurring. Table 2-6 of the Risk Assessment (Volume I) shows the county's Hazard Analysis Matrix which scores each hazard and provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard. Based on the matrix the **volcano hazard is rated #5, out of 9 rated hazards, with a total score of 173.**

Community Hazard Issues

Volcanic eruptions can send ash airborne, spreading the ash for hundreds or even thousands of miles. An erupting volcano can also trigger lahars, debris flows, floods, earthquakes, rockfalls,

²³ 2020 Oregon Natural Hazard Mitigation Plan. Department of Land Conservation and Development, 2020.

²⁴ Ibid.

and avalanches. Volcanic ash can cause respiratory problems, electrical storms, agricultural damage, roof collapse, and can contaminate water supplies and severely disrupt transportation.²⁵ Lava flows can crush or bury everything in their path, including structures, roads, railroads, power lines, gas lines, and other important infrastructure; lava flows can also dam rivers and streams, causing floods and contamination of drinking water, and they can ignite fires.

Businesses and individuals can make plans to respond to volcano emergencies. Planning is prudent because once an emergency begins, public resources can often be overwhelmed, and citizens may need to provide for themselves and make informed decisions. Knowledge of volcano hazards can help citizens make a plan of action based on the relative safety of areas around home, school, and work.²⁶

Building and Infrastructure Damage

Ashfall of 0.4 inches is capable of creating serious although temporary disruptions of transportation, operations, sewage disposal and water systems. The history associated with the Mount St. Helens eruption in 1980 resulted in closed highways, airports and other transportation systems for several days to, in some cases, weeks.

Ash can cause substantial problems for internal-combustion engines and other mechanical and electrical equipment. Additionally, it can contaminate filters, oil systems and scratch surfaces. Fine ash can cause short circuits in electrical transformers, which in turn cause power outages. Specifically in Deschutes County, ash can cause problems for the hi-tech manufacturing industry represented here.

The potential losses in Deschutes County extend beyond those to human life, homes, property and the landscape. Lahars and flooding, resulting from eruptions that melt snow and ice can result in severe damage to roads, bridges, pipelines and buildings. Highway 20 in Sisters, gas pipelines and high-capacity power lines on the flanks of Newberry Volcano are especially vulnerable.

Local business economies are at substantial risk if fallout from a volcanic event necessitates the closure of any of the major transportation routes in Deschutes County. The estimated loss per day is \$3.5 million.²⁷

Pollution and Visibility

Ash and tephra fallout from an eruption column can blanket areas within a few miles of the vent with a thick layer of pumice and ash. High altitude winds may carry finer ash from tens to hundreds of miles from the volcano, affecting downwind communities and posing a hazard to aircraft. Fine ash in water supplies will cause brief muddiness and chemical contamination. Ash suspended in the atmosphere is especially a concern for airports, where aircraft machinery

²⁵ Dzurisin, Dan, Peter H. Stauffer, and James W. Hendley II, Living With Volcanic Risk in the Cascades, USGS Fact Sheet 165-97, (2000).

²⁶ Scott, W.E. et al, Volcano Hazards in the Three Sisters Region, Oregon, USGS Open-File Report 99-437, (2001).

²⁷ Stutler, J. Informal survey during B & B Complex Fire, 2003.

could be damaged or clogged. Additionally, ashfall decreases visibility and disrupts daily activities.

Economic Impacts

Volcanic eruptions can disrupt the normal flow of commerce and daily human activity without causing severe physical harm or damage. Ash a few millimeters thick can halt traffic, possibly up to one week, and cause rapid wear of machinery, clog air filters, block drains and water intakes, kill or damage agriculture and severely impact tourism and the economy of the region. The interconnectedness of the region's economy can be disturbed after a volcanic eruption.

Losses to agriculture depend greatly on the crop type and the time in the growing season when ashfall occurs. Cook et al. (1981)²⁸ for example found that flat-leaved crops such as alfalfa suffered greater damage than vertical-stalk plants such as wheat due to the accumulation of ash on their leaves. Ash could not be easily washed off ripe raspberries, resulting in serious crop losses as eruptions occurred near harvest time.

Infrastructure can be impacted, particularly in Sisters which is particularly vulnerable to lahars and flooding. Transportation of goods between Deschutes County and nearby communities and trade centers could be deterred or halted. Subsequent airport closures can disrupt airline schedules for travelers. Fine ash can cause short circuits in electrical transformers, which in turn cause electrical blackouts. Volcanic activity can also force nearby recreation areas to close for safety precautions long before the activity ever culminates into an eruption. The interconnectedness of the region's economy would be disturbed after a volcanic eruption due to the interference of tephra fallout with transportation facilities such as the regional highways.

Death and Injury

Inhalation of volcanic ash can cause respiratory discomfort, damage or result in death for sensitive individuals miles away from the volcano. Likewise, emitted volcanic gases such as fluorine and sulfur dioxide can kill vegetation for livestock or cause a burning discomfort in the lungs. Hazards to human life from debris flows are burial or impact by boulders and other debris.

More information on this hazard can be found in the [Regional Risk Assessment for Region 6 of the Oregon NHMP](#).

Existing Authorities, Policies, Programs, and Resources

Existing authorities, policies, programs, and resources include current mitigation programs and activities that are being implemented by city, county, regional, state or federal agencies and/or organizations.

²⁸ Cook RJ, Barron JC, Papendick RI, Williams GJ (1981) Impact on Agriculture of the Mount St. Helens Eruptions. Science 211(4477):16-22

State

Central Cascades Volcano Coordination Plan, 2019

The purpose of this plan is to coordinate the actions that various agencies must take to minimize the loss of life and damage to property before, during, and after hazardous geologic events at Central Cascades volcanoes. The most current version of the Plan was completed in July 2019 and can be found here: <https://digital.osl.state.or.us/islandora/object/osl:857164>

State Natural Hazard Risk Assessment

The state risk assessment chapter on volcanic events provides a useful overview of volcanic risks in Oregon and documents historic volcanic activity. It also recommends a multi-hazard approach, given the uncertainty of most of Oregon being impacted by volcanic hazards in the foreseeable future.

A major existing strategy to address volcanic hazards is to publicize and distribute volcanic hazard maps through DOGAMI and USGS. The volcanoes most likely to constitute a hazard to Oregon communities have been the subject of USGS research. Open-file reports (OFR) address the geologic history of these volcanoes and lesser-known volcanoes in their immediate vicinity. These reports also cover associated hazards and possible mitigation strategies. They are available for volcanoes near Deschutes County including: Mount Saint Helens, Three Sisters, Newberry Volcano, and Crater Lake.

Federal

Volcano Monitoring

USGS and Pacific Northwest Seismic Network at the University of Washington conduct seismic monitoring of major Cascade volcanoes in Washington and Oregon. The USGS serves as the primary dissemination agency for emergency information. As activity changes, USGS scientists provide update advisories and meet with local, state, and federal officials to discuss the hazards and appropriate levels of emergency response.²⁹

Techniques for monitoring active or potentially active volcanoes focus on three areas—earthquakes (seismicity), ground deformation, and volcanic gases. Magma intruding a volcanic system breaks rock and causes slippage on faults, thereby creating earthquakes; it adds material at depth and heats and pressurizes ground water, thereby bowing up the ground surface; and it releases volcanic gases, mainly water vapor, carbon dioxide, and sulfur dioxide. Heat and volcanic gases from magma warm and add telltale chemicals to the ground water, which affects the composition of spring water throughout the area.

Some monitoring occurs in real-time or near real-time as data are telemetered from field sites to base stations; other monitoring is done on a periodic basis and requires visits to the field or gathering data from satellites.

²⁹ Central Cascades Volcano Coordination Plan, 2007.

Earthquakes in central Oregon are detected and located in real-time by the Pacific Northwest Seismic Network (PNSN) at the University of Washington, a cooperative undertaking of the university, USGS, and University of Oregon. Compared to areas that have frequent earthquakes, the station spacing in central Oregon is relatively large, so only earthquakes greater than magnitude (M) 1 or 2 are able to be located routinely. A small network of seismic stations (10) are operated in and around the Three Sisters area. Several of these stations were added after an ongoing uplift was recognized in 2001. The magnitude threshold for locatable earthquakes has now been reduced to about M 0.5 to 1, if all stations are operating. Nine seismometers on or near Newberry Volcano and a couple more at somewhat greater distance have significantly reduced the magnitude threshold for location of earthquakes on Newberry. In addition, a cache of instruments at USGS Cascades Volcano Observatory is available to rapidly augment the existing networks should conditions warrant.

Continuous Global Positioning System (CGPS) receivers are able to track ground deformation in real time for a single point on Earth's surface. At present CGPS receivers at Redmond, Mount Bachelor, and two near South Sister operate in real time. Such a sparse network is of limited use in understanding the complex nature of ground deformation in a volcanic environment. Eight CGPS receivers were installed at Newberry Volcano, along with seismometers, in 2011. This network significantly improved monitoring capabilities at Newberry.

Broader regional coverage is afforded by periodic USGS surveys (typically annual or every few years; more often if conditions warrant) of an array of benchmarks in the Three Sisters and Newberry areas by temporary deployment of GPS instruments. Both areas also have a system of precisely surveyed lines along roads or trails that are used for tilt leveling, a procedure that is capable of measuring slight crustal movements. Another technique called InSAR uses satellite radar data to detect crustal movements over broad areas.

USGS scientists measure output of volcanic gases by airborne surveys. Flights to central Oregon volcanoes are made every few years in order to develop baseline information; additional flights occur as conditions warrant. During times of increased concern, flights could occur as often as atmospheric conditions allow. Annual sampling and chemical and isotopic analysis of spring water from the area permit a broad regional view of how magmatic intrusion is affecting the chemical composition of shallow ground water.

By combining the results of these and other techniques and an understanding of a volcano's past behavior, the goal of volcano monitoring is to issue forecasts as accurately as possible about the state of a volcanic system and the probability for the onset of potentially hazardous conditions. Once an eruption has begun, monitoring information is used to forecast the character and expected outcome of the eruption, as well as its end.³⁰

Emergency Coordination

During times of volcanic crisis, USGS scientists will monitor events closely and, together with PNSN and the Oregon Department of Geology and Mineral Industries, issue information statements, alert warnings, updates, and briefings as necessary to keep public officials, the media, and the public aware of potential hazards and other pertinent information. The USGS

³⁰ USGS-Volcano Hazards Program, <http://volcanoes.usgs.gov/observatories/cvo/>

and the National Weather Service will work together to provide warnings about lahars, floods, and downwind ash-fall hazards.

Currently, agencies require information on hazards that affect nearby areas much like airlines and the Federal Aviation Administration require information on tephra plumes that can be hazardous to aircraft hundreds of miles from the source. The information required by these two groups is not always the same, and therefore the USGS in cooperation with various agencies, has developed two hierarchies of alert levels; one directed toward emergency response on the ground and the other towards ash hazards to aircraft.

The USGS issues statements of ground-based hazards which are transmitted as appropriate to state and federal agencies including FEMA and the National Weather Service. The counties receive information from Oregon Emergency Management then transmit the notifications as appropriate to local emergency management networks.³¹

Warning Systems

The best warning of a volcanic eruption is one that specifies when and where an eruption is most likely to occur and what type and size eruption should be expected. Such accurate predictions are sometimes possible but still warrant further research. The most accurate warnings are those in which scientists indicate an eruption is probably hours to days away based on significant changes in a volcano's earthquake activity, ground deformation and gas emission. Experience from around the world has shown that most eruptions are preceded by such changes over a period of days to weeks.

A volcano may begin to show signs of unrest several months to a few years before an eruption. In these cases a warning that specifies when it might erupt months to years ahead of time are extremely rare. The strategy that the USGS uses to provide volcano warnings in the Cascade Range volcanoes in Washington and Oregon involves a series of alert levels that correspond generally to increasing levels of volcanic activity. As a volcano becomes increasingly active or as incoming data suggest that a given level of unrest is likely to lead to a significant eruption, the USGS declares a corresponding higher alert level. This alert level ranking thus offers the public and civil authorities a framework they can use to gauge and coordinate their response to a developing volcano emergency.

Education and Outreach

General information on volcano hazards may be found on the USGS Volcano Hazards website: <http://volcanoes.usgs.gov>.

USGS Open File Reports describe the geographic extent of impacts from volcanic activity originating in the Cascades and can be found on the USGS Cascades Volcano Observatory website: <http://volcanoes.usgs.gov/observatories/cvo/>. Teaching resources can be found on the USGS Cascades Volcano Observatory website: <https://www.usgs.gov/observatories/cascades-volcano-observatory/teaching-resources>

³¹ Scott, W.E. et al, Volcano Hazards in the Three Sisters Region, Oregon, USGS Open-File Report 99-437, (2001).

Hazard Mitigation Action Items

There is one identified Volcano action item for Deschutes County; in addition, several of the Multi-Hazard action items affect the Volcano hazard. An action item matrix is provided within Volume I, Section 3, while action item forms are provided within Volume IV, Appendix A. To view city actions see the appropriate city addendum within Volume III.

Significant changes since the 2015 Plan

Significant changes to this section include additional information on the 2020 Oregon wildfires. Several tables, figures, and maps were updated as well as the history of wildfires, population growth, and a new fire district in Alfalfa was added. Information on CWPPs was updated and risk information replaced with data from the Oregon Wildfire Risk Explorer (OWRE) where available. Information on air quality and smoke impacts was added.

Causes and Characteristics of the Hazard

Wildfire is a natural and necessary component of ecosystems across the country. Central Oregon is no exception. Historically, wildland fires have shaped the forests and wildlands valued by residents and visitors. These landscapes however, are now significantly altered due to fire prevention efforts, modern suppression activities and a general lack of large-scale treatments, resulting in overgrown forests with dense fuels that burn more intensely than in the past. In addition, the recent explosion in population has led to increased residential development into forested land, in the wildland urban interface (WUI). Assessment of wildfire vulnerability and the identification of mitigation actions is largely dealt with at the community level through each of the County's Community Wildfire Protection Plans; further information on the CWPPs is provided below beginning on page II-80.

The impact on communities from wildfire can be huge. In 1990, Bend's Awbrey Hall Fire destroyed 21 homes, caused \$9 million in damage and cost more than \$2 million to suppress. The 1996 Skeleton fire in Bend burned over 17,000 acres and damaged or destroyed 30 homes and structures. Statewide that same year, 218,000 acres burned, 600 homes were threatened and 44 homes were lost. These wildfire events provided an impetus for addressing wildland urban interface development and hazardous fuel mitigation statewide.

As development continues in the wildland urban interface, increasing numbers of residents are at risk from wildland fires. The Labor Day fires of 2020 in Western and Southwestern Oregon demonstrated the significant risks many of our community's face. High winds fanned existing fires and caused additional fires throughout Oregon. Eleven lives were lost, over 4000 homes destroyed and a million acres of Oregon burned during the fires. 38% of the homes destroyed were within urbanized cities and demonstrate the risk posed to communities that do not meet the traditional definition of Wildland Urban Interface and quickly turn into an urban conflagration. Current building codes in Deschutes County, and most of Oregon, do not require homes to be built to wildfire resistant standards. This results in homes becoming fuel for wildfires in the wildland urban interface.

Wildfire can be divided into three categories: wildland, interface and urban conflagration. Any of these fires can occur in Deschutes County. Deschutes County experiences interface fires each summer that prompts at least one neighborhood evacuation.

Wildland Fires

A wildland fire's main fuel source is natural vegetation. Often referred to as forest or rangeland fires, these fires occur in national forests and parks, private timberland, and on public and private rangeland. A wildland fire can become an interface fire if it encroaches on developed areas.

Interface Fires

Essentially, an interface fire occurs where wildland and developed areas meet. In these locations, both vegetation and structural development combine to provide fuel. The wildland/urban interface (sometimes called rural interface in small communities or outlying areas) can be divided into three categories.

1. The classic wildland/urban interface exists where well-defined urban and suburban development presses up against open expanses of wildland areas.
2. The mixed wildland/urban interface is more typical of the problems in areas of exurban or rural development: isolated homes, subdivisions, resorts and small communities situated in predominantly wildland settings.
3. The occluded wildland/urban interface where islands of wildland vegetation exist within a largely urbanized area.

Urban Conflagration

Urban conflagrations are a result of fires spreading from wildland fuels into developed areas and moving from structure to structure. These fires burn from structure to structure independent of wildland fuels and are resistant to control.

Structures burn with such extreme intensity that effective suppression is virtually impossible. Wildland fuels are generally not the leading factor of urban conflagration fires. The 2020 Alameda Fire burned through the cities of Talent and Phoenix, Oregon burning 2,800 home in just 3,600 acres is an example of an interface fire that developed into an urban conflagration.

Conditions Contributing to Wildfires

Ignition of a wildfire may occur naturally from lightning or from human causes such as debris burns, arson, smoking, and recreational activities or from an industrial accident. Once started, three main conditions affect the fire's behavior: fuel, topography and weather.

Fuel is the material that feeds a fire. Fuel is classified by volume and type. As a western state, Oregon is prone to wildfires due to its prevalent conifer, brush and rangeland fuel types.

Topography influences the movement of air and directs a fire's course. Slope is a key factor in fire behavior. Unfortunately, hillsides with steep topographic characteristics are also desirable areas for residential development.

Weather is the most variable factor affecting wildfire behavior. High risk areas in Oregon share a hot, dry season in the summer months and early fall with high temperatures and low humidity.

The increase in residential development in interface areas has resulted in greater wildfire risk due to increased values at risk and human activities in our forests. Typically, it is the embers/fire brands that ignite homes rather than the flaming front; as such, defensible space and fire-resistant building materials are often the best mitigation strategies. New residents in remote locations are often surprised to learn that in moving away from built-up urban areas, they have also left behind readily available fire services providing structural protection.

History of Wildfires in Deschutes County

Table II-7 lists the significant large wildland fires in Deschutes County over the last three decades. These fires required a substantial emergency management response from firefighting resources.

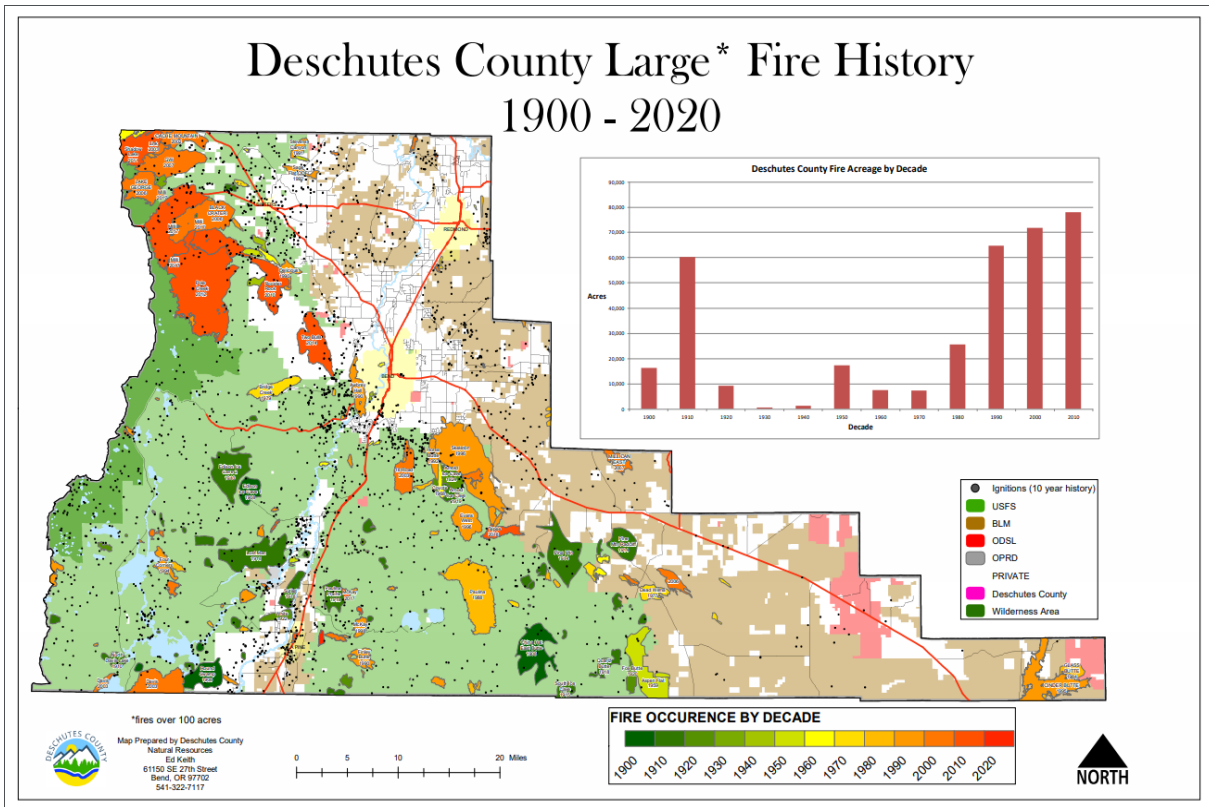
Table II-7 Large Wildfire History (1990 to present)

Date	Fire Name	Acres Burned
2018	Tepee	2,027
2017	Milli	24,000
	McKay	190
2014	Two Bulls	6,908
2013	Burgess Road	168
2012	Pole Creek	26,795
2011	Shadow Lake	10,402
2010	Rooster Rock	6,120
2009	Black Butte II	569
2008	Summit Springs Complex	1,973
2007	GW	8,570
2006	Lake George	5,652
	Black Crater	9,412
2005	Park	139
2003	Davis	21,123
	Link	3,716
	18 Road Fire	3,811
	B & B Complex	90,769
	Cache Mountain	4,451
2001	Crane Complex	713
2000	Hash Rock	18,500
1998	Elk Lake	252
	McKay	1,150
1996	Little Cabin	2,400
	Smith Rock	300
	Skeleton	17,794
	Evans West	4,231
1995	Cinder Butte	11,132
1994	Four Corners	1,524
1992	Sage Flat ODF	1,106
	Horse Butte	1,629
1991	Stevens Canyon	1,080
1990	Awbrey Hall	3,032
	Delicious	2,042
	Finley Butte	1,320

Source: Deschutes County Forestry, 2021.

The local structural and wildland fire organizations have significantly refined the coordinated emergency response system for these types of destructive interface fires. Under the leadership of the Central Oregon Fire Chiefs Association (COFCA), the pre-planned interface fire mutual aid and task force system has effectively integrated the operational response process for structural and wildland firefighting resources from all three counties. This response system is recognized as one of the most effective interagency efforts in the state. As is the case with the regional focus of Table II-7, much of the wildland fire section of this plan is presented with a regional focus on Crook, Deschutes and Jefferson counties. The scope and multi-jurisdictional nature of local wildland fire demand has driven development of a regional approach that addresses pre-incident planning, training, initial and extended response during incidents, and recovery activities. Fire service leadership broadly acknowledges the benefit of this type of coordinated approach as essential to meeting the local wildfire challenge.

Figure II-19 Large Wildfire History



Source: Deschutes County Forester, 2021.

Another measure of the scope and impact of the wildland fire issue, particularly in the wildland-urban interface (WUI) is illustrated by data developed in the Central Oregon Fire Atlas. The Nature Conservancy produced the Fire Atlas as a part of their Fire Learning Network initiative. The Fire Atlas focuses on 2.05 million acres in Klamath, Deschutes and Jefferson counties and was used by stakeholders and community members to visualize wildfire risk in relation to regional landscapes and vegetation regimes, their location in relation to communities, and the history of past wildfires.¹

The tables below illustrate not only the escalating size of large wildland fires in Deschutes County, but also the increasing impact on the citizens, values-at-risk and infrastructure of the county.

Table II-8 Acres Burned by Decade

Decade	Acres Burned
1900 - 1909	16,200
1910 - 1919	60,400
1920 - 1929	9,200
1930 - 1939	600
1940 - 1949	1,400
1950 - 1959	17,400
1960 - 1969	7,400
1970 - 1979	7,400
1980 - 1989	25,600
1990 - 1999	64,700
2000 - 2009	71,900
2010-2019	98,600
Summary	
1900-1999	210,300
2000-present	170,500

Source: Deschutes County Forestry (2014) and Oregon Wildfire Risk Explorer (2021)

The significant story here is that Deschutes County has experienced high intensity wildland fires on 45% more acreage in the last 19 years than in the previous 100 years combined. The following table details the structures lost since 1981. The table shows that the majority of structures lost occurred during events in 1990 and 1996; since 2019 there have been no structures lost in the county due to wildland fire.

¹ See more at: <https://www.conservationgateway.org/News/Pages/deschutes-fln-helps-commu.aspx#sthash.Ok6rrEmA.dpuf>

Table II-9 Structures Lost to Wildland Fire

Year	Structures Lost
2019	1
2018	3
2003	1
2002	20
2001	5
1996	30
1990	22
1981	5
Total	87

Source: Central Oregon Interagency Dispatch Records, 2021

The escalating size and intensity of these interface fires is the subject of continuing research in several scientific disciplines. These include the arenas of forest health, hazardous fuels treatment and community infrastructure protection; as well as studies of the impacts of climate change. These issues are likewise the subject of significant public discourse. Over the last two decades, community awareness and participation has developed substantially regarding the interface fire threat. Participation hazardous in fuel reduction and wildfire preparedness activities within neighborhoods in Deschutes County increases with each passing fire season.

Central Oregon population growth has become a companion issue. In 1980, Deschutes County population was estimated to be 62,500. In 20 years, by 2000, it had nearly doubled to 115,367 and by July 1st 2020 it had increased another 71% to 197,015. The 2004 Coordinated Population Forecast for Deschutes County (updated in 2018) estimates the 2043 county population to increase by another 114,000 over the next 25 years to 311,015. This trend of rapid population growth will have significant impacts on citizen exposure, infrastructure vulnerability, and economic losses to the effects of wildland fire.

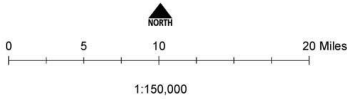
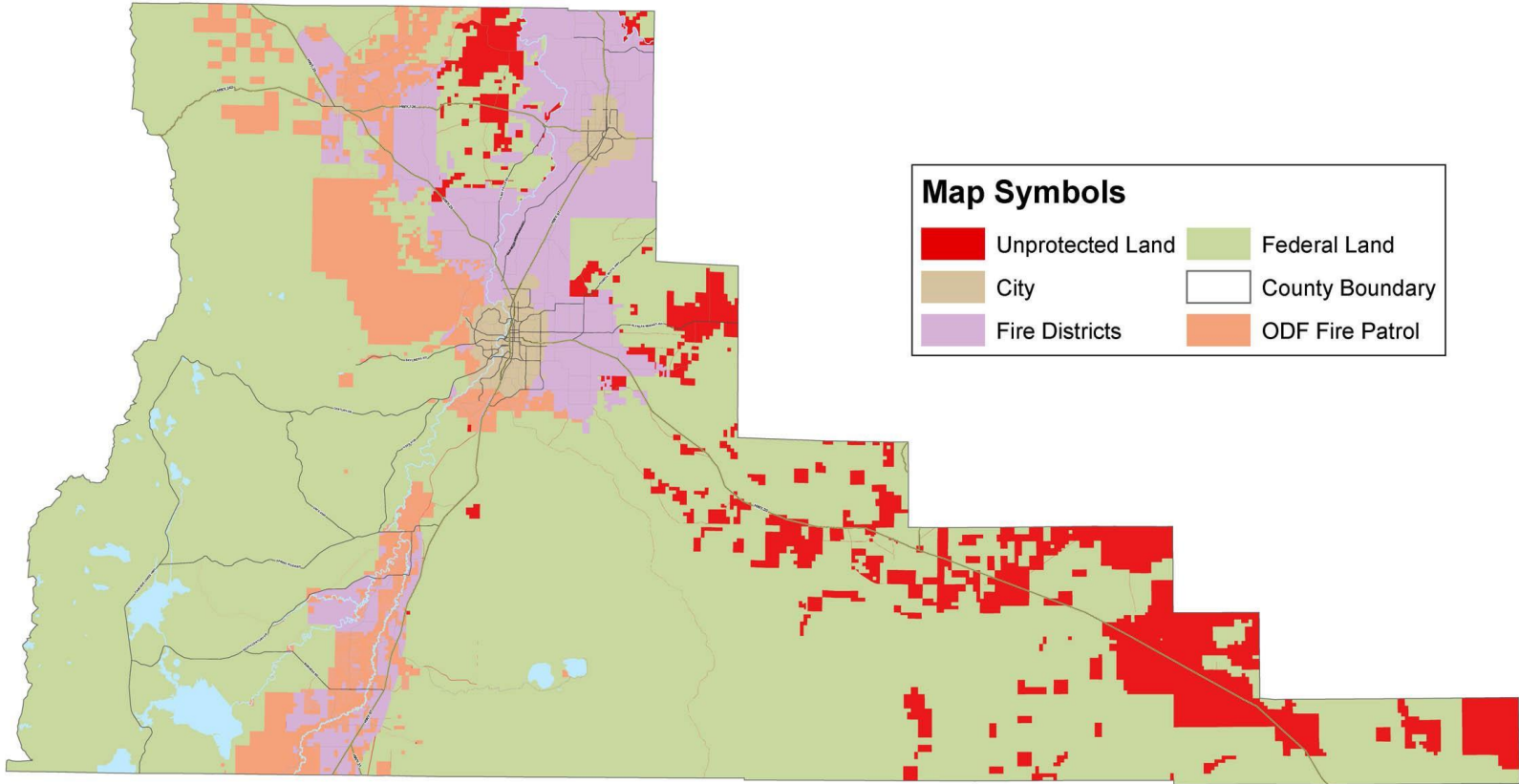
Deschutes County includes approximately 175,400 acres of unprotected lands (see Figure II-21 for a map of the protected and unprotected lands within Deschutes County). Throughout eastern Oregon approximately eight million acres of unprotected, privately owned wildland areas exist. In Deschutes County there are several examples of residential development that are under protected from fire These include the Lower Bridge area east of Sisters, and the Brothers and Hampton areas along Highway 20 on the eastern edge of the county. In addition, there are approximately 100,000 acres of privately-owned rangeland east of Bend that do not have structural fire protection and receive some wildland fire protection from Rangeland Fire Protection Associations. Alfalfa, a community located east of Bend, passed a bond measure in 2014 to fund a fire district that currently provides fire protection to its residents, signifying the only expansion in protected lands since the last NHMP update in 2015.

Because these types of areas have limited fire protection and because of the light, flashy nature of the fuel types present in some areas, wildland fires have the potential to get quite large,

often spreading to the point where they become a threat to protected areas. In Deschutes County, county code 8.21 has been developed that outlines a system for landowners to respond to the wildland fire threat with defensible space and fire breaks on private property in the unprotected areas.

There are likewise substantial resource commitments and fiscal costs associated with emergency response to wildland fire incidents. This impact on local organizations was demonstrated by the multiple agency organizational response each fire season. Notable recent incidents that exemplify the impact on local organizations are Pole Creek (2012), Burgess Road (2013), Two Bulls (2014) and Milli (2017). The costs associated with multiple day mobilization of law enforcement, search and rescue, structural fire assets and state fire resources can quickly deplete local and state agency budgets. Residential evacuation triggers American Red Cross mobilization and when major transportation routes are impacted, Oregon Department of Transportation and County Road Department personnel are also mobilized. Depending on the scope and specifics of an individual fire, additional agency and non-governmental support organizations may also be mobilized to help mitigate the impact on citizens and community infrastructure.

Figure II-21 Deschutes County Fire Protection



Source: Deschutes County Forester, 2021

The rapid rates of spread and higher fire intensity observed in the recent past have raised the awareness level of the public and local public safety officials. Public safety and structural mobilization, at some level, occurs shortly after the initial smoke report for every wildland fire with wildland urban interface threat potential in Deschutes County

Much of the public policy discussion associated with the wildland urban interface at federal, state and local levels have been focused on resources and public safety issues. While that will continue to be an important component of future initiatives, these examples of rapidly moving, high intensity fires with long-range spotting demonstrate the need for coordinated fuels treatment strategies and public education efforts that address fire behavior and preparedness issues for several miles beyond private and public land boundaries.

Hazard Identification

Deschutes County is generally considered within two vegetative ecosystems:

- The “high desert” dominated by Western juniper, sagebrush and a variety of grass species to the east, and
- To the west, a transition from dry-site ponderosa and lodgepole pine to mixed conifer to a sub-alpine mix of tree species near the crest of the Cascades.

The boundary between these two general eco-types is driven for the most part by elevation, precipitation and soil moisture-holding capacity.

Central Oregon Fire Adapted Ecosystems

Most central Oregon ecosystems, particularly those at low and mid elevations adjacent to most community and residential development, are described as fire adapted. Vegetative species in these areas have evolved in and are dependent on relatively short fire return intervals. Over the last 100+ years, fire suppression and forest management activities have altered this natural fire return interval. This has created species shifts and increases in stand density and forest fuels. This change has increased susceptibility of the forest to insects, diseases and to wildland fire.² Inventory and analysis of this shift by the Central Oregon Fire Management Service (COFMS) stratifies the national forest and adjacent lands into one of three Condition Classes based on the number of “missed” fire cycles.³

Vegetative Mapping for Fire Regime and Condition Class

The Deschutes National Forest, Ochoco National Forest and the Prineville District of the Bureau of Land Management, working together as Central Oregon Fire Management Services (COFMS) review, and edit if necessary, the Central Oregon Fire Management Plan on an annual basis. Included in that plan is an extensive Fire Regime and Condition Class analysis of the condition of the vegetation on the public lands managed by the agencies.

² Fitzgerald, S., OSU Extension Wildland Forest Specialist, interview March 2004.

³ Central Oregon Fire Management Plan, Central Oregon Fire Management Service.

Because of the wide variability in vegetative types in central Oregon, the Fire Regime – Condition Class approach was selected as the best method to describe the range of conditions present on the ground.

Fire Regime - Condition Class considers the type of vegetation and the departure from its natural fire behavior return interval. Five natural (historical) fire regimes are classified based on the average number of years between fires (fire frequency) combined with the severity of the fire on dominant overstory vegetation. Western juniper, for example has a fire return interval of approximately 30 years with high potential for stand replacement fires. Therefore, it falls within Fire Regime II.

Table II-10 Fire Regimes

Fire Regime Group	Fire Frequency	Fire Severity	Plant Association Group
I	0 - 35 years	Low severity	Ponderosa pine, manzanita, bitterbrush
II	0 - 35 years	Stand replacement	Western juniper
III	35 - 100+ years	Mixed severity	Mixed conifer dry
IV	35 - 100+ years	Stand replacement	Lodgepole pine
V	> 200 years	Stand replacement	Western hemlock, mixed conifer wet

Source: Deschutes County CWPPs

Condition Class categorizes a departure from the natural fire frequency based on ecosystem attributes. In Condition Class 1, the historical ecosystem attributes are largely intact and functioning as defined by the historical natural fire regime. In other words, the stand has not missed a fire cycle. In Condition Class 2, the historical ecosystem attributes have been moderately altered. Generally, at least one fire cycle has been missed. In Condition Class 3, historical ecosystem attributes have been significantly altered. Multiple fire cycles have been missed. The risk of losing key ecosystem components (e.g. native species, large trees, soil) is low for Class 1, moderate for Class 2, and high for Class 3.

Table II-11 Condition Class

Condition Class	Attributes
Condition Class 1	<ul style="list-style-type: none"> *Fire regimes are within or near an historical range. *The risk of losing key ecosystem components is low. *Fire frequencies have departed from historical frequencies (either increased or decreased) by no more than one return interval. *Vegetation attributes are intact and functioning within an historical range.
Condition Class 2	<ul style="list-style-type: none"> *Fire regimes have been moderately altered from their historical range. *The risk of losing key ecosystem components has increased to moderate. *Fire frequencies have departed (either increased or decreased) from historical frequencies by more than one return interval. This change results in moderate changes to one or more of the following: fire size, frequency, intensity, severity or landscape patterns. *Vegetation attributes have been moderately altered from their historic ranges.
Condition Class 3	<ul style="list-style-type: none"> *Fire regimes have been significantly altered from their historical range. *The risk of losing key ecosystem components is high. *Fire frequencies have departed (either increased or decreased) by multiple return intervals. This change results in dramatic changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns. *Vegetation attributes have been significantly altered from their historic ranges.

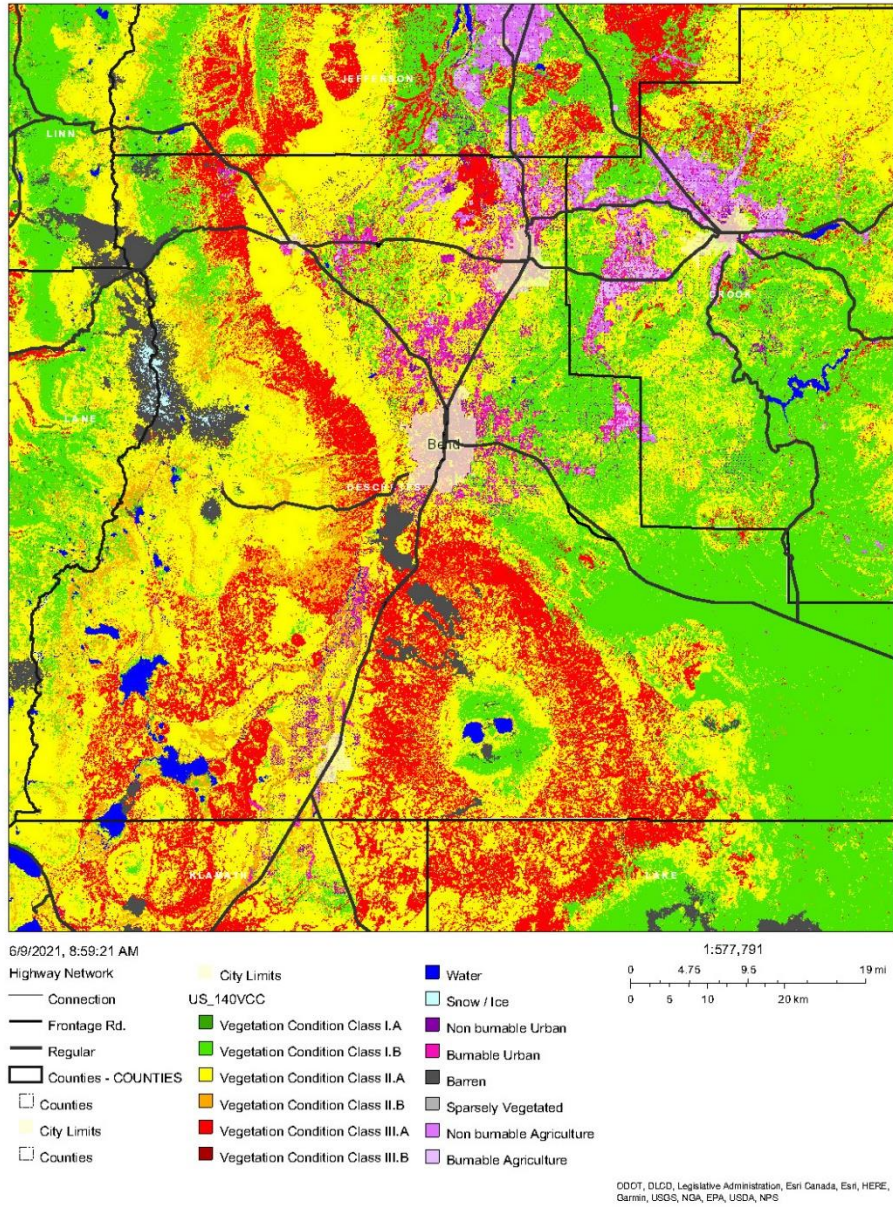
Source: Deschutes County CWPPs

While each of the fire regimes described exist in Deschutes County, Fire Regime I and Fire Regime II generally describe the forest condition that is present at the lower elevations adjacent to the more densely populated, wildland urban interface (WUI) areas of the county. The forest vegetative species shift cited above however is causing a greater presence of Fire Regime III at lower elevations with an increasing dominance of non-native species and increased fuels loading in those sites. This results in higher levels of fire intensity, crowning and spotting potential.

In Deschutes County, the majority of public lands are in Condition Class 2 or 3, having missed one or two (or more) fire return intervals. Ground vegetation and tree saplings have grown unchecked by natural fire contributing significantly to the potential for extreme fire behavior including crowning, torching and spotting.

Figure II-22 Deschutes Fire Regime Condition Class

Deschutes Fire Regime Condition Class



Deschutes County FACC
Esri Canada, Esri, HERE, Garmin, USGS, NOAA, EPA, USDA, NPS | BLM Energy, Minerals & Realty Management | ODOT, DLCD, Legislative Administration | Oregon Department of Transportation | ODOT |

Source: Deschutes County FACC

Fire Behavior

Wildland fire behavior is comprised of three components: fuels, topography and weather. While these three parameters individually define fire behavior, their interactive dynamics offer insight for effective mitigation approaches. The fire behavior triangle helps demonstrate the relationship between these three parameters.

The **fuels** aspect of fire behavior takes into consideration loading, size and shape, compactness, horizontal and vertical continuity and chemical composition. Each of these parameters offers opportunities for effective hazardous fuels treatment mitigation actions. Due to the dry nature of most areas of Deschutes County, many of the brush species contain a significant amount of volatile, highly flammable oils and resins (e.g. bitterbrush). These relatively low profile fuels can generate very intense, high flame length fire behavior. This is similar to fires observed in the chaparral fires in southern California.

Topography takes into account elevation and slope position and steepness, aspect and shape of the country. Deschutes County's west boundary lies at the crest of the Cascade Mountains generally about 6,000 to 7,000 feet. The elevation falls off to the east, transitioning through the lower slopes and foothills of the Cascades, crossing the Deschutes River and progressing down to about 3,000 feet in the high desert. This generally gives the area an east and south aspect, which provides strong solar exposure throughout most of the day. The Cascades also act as a barrier to the prevailing westerly winds. This creates a rain shadow effect that limits precipitation on the east side of the mountains and contributes to gusty, turbulent, dry cold front passages that have historically contributed to high intensity fires with rapid rates of fire spread and medium to long range spotting.

As mentioned above and described in Appendix C, Central Oregon weather is strongly affected by the Cascade Mountains. The relatively low precipitation, particularly at lower elevations adjacent to areas of community development, strong solar radiation and gusty wind patterns combine to generate a fairly dry environment.

There are some opportunities to compensate for the wildland interface fire exposure effects of local dry climatic conditions and weather patterns by consideration of topographic features during home construction and development planning. Overall, however, the greatest potential to impact fire behavior lies with hazardous fuels management, varying in scope from defensible space around individual homes and structures to well planned, landscape scale treatments to mimic the effects of periodic low intensity fire.

In Central Oregon, forests ecologically within the historical norm are also more fire tolerant and are less susceptible to high intensity, stand replacement fires. Ultimately, fire behavior is related to the structure of the forest fuels. Hazardous fuels treatment strategies are the subject of ongoing research efforts.⁴

The Wildland Urban Interface of Deschutes County

Over the last twenty years, public recognition of the term "wildland urban interface" (WUI) has become greater with increased incidences of wildland fires, loss of residences, and highly visible smoke columns. The term "wildland urban interface" describes the boundary and intermixture of structural development adjacent to and within areas dominated by wildland fire vegetation. Fire suppression tactics in interface areas, both structural and wildland, are continually adapting to provide better safety for firefighters and the public.

⁴ Science Basis for Changing Forest Structure to Modify Wildfire Behavior and Severity by Russell T. Graham, Sarah McCaffrey, and Theresa B. Jain. RMRS-GTR-120, USDA Forest Service, 2004.

Probability Assessment

In Oregon, wildfires are inevitable. Although usually thought of as being a summer occurrence, wildland fires can occur during any month of the year. The vast majority of wildfires burn during the June to October time period. Dry spells during the winter months, especially when combined with winds and dead fuels, may result in fires that burn with intensity and a rate of spread that cause difficulty for local resources that typically don't have their full staffing in the winter season. Wildfire risk to human welfare and economic and ecological values is more serious today than in the past because of the buildup of flashy fuels, changes in vegetation composition over time, construction of houses in proximity to forests and rangelands, increased outdoor recreation, and a lack of public appreciation of wildfire.⁵

The natural ignition of forest fires is largely a function of weather and fuel; human-caused fires add another dimension to the probability. Dry and diseased forests can be mapped accurately and some statement can be made about the probability of lightning strikes. Each forest is different and consequently has different probability and recurrence estimates. Wildfire has always been a part of these ecosystems and sometimes with devastating effects. The intensity and behavior of wildfire depends on a number of factors including fuel, topography, weather, and density of development. There are a number of often-discussed strategies to reduce the negative impacts of these phenomena. They include land-use regulations, management techniques, site standards, and building codes. All of these have a bearing on a community's ability to prevent, withstand, and recover from a wildfire event.

Deschutes County's Natural Hazards Mitigation Steering Committee believes that the County's **probability of experiencing a wildfire event is "high,"** meaning at least one incident is likely within the next 10 – 35 year period (as the history of wildfires indicates, it is likely that Deschutes County will experience a wildfire on an annual basis). Based upon available information the Oregon NHMPs Regional Risk Assessment supports this probability rating for Deschutes County.⁶

Future Climate Variability

One of the main aspects of the probability of future occurrences is its reliance on historic climate trends in order to predict future climate trends. Counties east of the Cascade Mountain Range in Oregon are experiencing more frequent and severe wildfires than is historically the norm, and many climate predictions see this trend continuing into the future. Temperature increases will occur throughout all seasons, with the greatest variation occurring during summer months. Hotter temperatures mean more combustible vegetation. This information was considered while developing the probability of wildfire occurrence for the county.

Vulnerability Assessment

Wildfires are a natural part of forest and grassland ecosystems. Past forest practices included the suppression of all forest and grassland fires. This practice, coupled with hundreds of acres of dry brush or trees weakened or killed through insect infestation, has fostered a dangerous

⁵ Ibid

⁶ 2020 Oregon Natural Hazard Mitigation Plan. Department of Land Conservation and Development, 2020.

situation. Present state and national forest practices include the reduction of understory vegetation through thinning, mastication and prescribed (controlled) burning.

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

Each Community Wildfire Protection Plan (CWPP) utilized a variety of hazard assessment tools depending on the vegetation ecotypes of the Communities at Risk within each CWPP. CWPPs that have been updated within the last 2 years use the new Oregon Wildfire Risk Explorer tool (OWRE) to conduct the risk assessment. The OWRE Advanced Report provides wildfire risk information for a customized area of interest to support Community Wildfire Protection Plans (CWPPs), Natural Hazard Mitigation Plans (NHMPs), and fuels reduction and restoration treatments in wildfire-prone areas in Oregon. The assessment uses the most current data and state-of-the-art fire modeling techniques, and is the most up-to-date wildfire risk assessment for Oregon. Moving forward, all CWPPs will use the OWRE to assess risk.

Over the last five years, collaborative groups in each of seven CWPP areas met to conduct these assessments and determine priorities for fuels reduction activities on public and private lands. Each CWPP and year of update (and next expected revision) is listed below:

- Greater Bend CWPP (2016, expected revision 2021)
- Greater La Pine CWPP (2020, expected revision 2025)
- Greater Redmond CWPP (2018, expected revision 2023)
- Greater Sisters Country CWPP (2019, expected revision 2024)
- Sunriver CWPP (2020, expected revision 2025)
- East and West Deschutes County CWPP (2018, expected revision 2023)
- Upper Deschutes River Coalition CWPP (2018, expected revision 2023)

While the formatting changes some between the CWPPs, the priorities and goals are the same across all the CWPPs. The following table details these shared priorities. To view in detail the CWPPs above, visit <https://www.projectwildfire.org/cwpps/>

Table II-12 Summary of CWPP Priorities

Communities at Risk - Priorities
Reduce hazardous fuels on public lands
Reduce hazardous fuels on private lands (both vacant and occupied)
Reduce structural vulnerability
Increase education and awareness of wildland fire threat
Identify, improve and protect critical transportation routes

Source: Deschutes County CWPPs

Notes: While the formatting changes between the CWPPs, the priorities and goals are the same across all the CWPPs; more information can be found in each community's Community Wildfire Protection Plan.

The Deschutes County CWPPs utilized the Oregon Department of Forestry Assessment of Risk methodology to determine community risk. The assessment used a scoring matrix with six factors: likelihood of fire occurring (Risk), hazard (based on weather, topography, and fuel), protection capability, values protected, and structural vulnerability.⁷ The hazard assessment information was used to develop a scoring matrix that would provide results that was used for prioritizing the WUI areas.

The Deschutes County Natural Hazards Steering Committee rated Deschutes County as having a **“high” vulnerability to wildfire hazards**; meaning more than 10% of the region’s population or assets would be affected by a major emergency or disaster. Based upon available information the Oregon NHMPs Regional Risk Assessment supports this vulnerability rating for Deschutes County.⁸

Risk Analysis

The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section), and (2) the likelihood or probability of the harm occurring. Table 2-6 of the Risk Assessment (Volume I) shows the county’s Hazard Analysis Matrix which scores each hazard and provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard. Based on the matrix the **wildfire hazard is rated #2, out of 9 rated hazards, with a total score of 220.**

Community Hazard Issues

Threat to Life and Property

The interface between urban and suburban areas and these resource lands are producing increased exposure to life and property from wildfire. In many cases, existing fire protection services cannot adequately protect new development. Wildfires that also involve structures present complex and dangerous situations to firefighters.

Personal Choices

Many interface areas, found at lower elevations and drier sites, are also desirable real estate. More people in Oregon are becoming vulnerable to wildfire by choosing to live in wildfire-prone areas.⁹

A community at risk is a geographic area within and surrounding permanent dwellings (at least one home per 40 acres) with basic infrastructure and services, under a common fire protection jurisdiction, government, or tribal trust or allotment, for which there is a significant threat due to wildfire.

⁷ Deschutes County CWPPs. <https://www.projectwildfire.org/cwpps/>

⁸ Ibid.

⁹ National Wildland/Urban Interface Fire Protection, Fire protection in the Wildland/Urban Interface: Everyone’s responsibility, Washington D.C., (1998).

Private Lands

Private development located outside of rural fire districts where structural fire protection is not provided is at risk. In certain areas fire trucks cannot negotiate steep grades, poor road surfaces, narrow roads, flammable or inadequately designed bridges, or traffic attempting to evacuate the area. Little water during the fire season, and severe fuel loading problems add to the problem. In some areas, current protection resources are stretched thin, thus both property in the interface and traditionally protected property in the forests and cities are at greater risk from fire. While the Firewise program has increased knowledge of the fire risk and preparedness for fire season however, many property owners in the interface are not aware of the problems and threats that they face, and owners in some areas have done little to manage or offset fire hazards or risks on their own property.

Drought

Recent concerns about the effects of climate change, particularly drought, are contributing to concerns about wildfire vulnerability. Unusually dry winters and hot summers increase the likelihood of a wildfire event, and place importance on mitigating the impacts of wildfire before an event takes place.

More information on this hazard can be found in the Regional Risk Assessment for Region 6 of the Oregon NHMP.

Wildfire Smoke

History

Deschutes County and some of the cities in the County have had a history of some elevated particulate matter concentrations from the 1980s when air quality measurements were first taken. Woodstoves, open burning, and burn barrels were the initial issue causing elevated winter time levels of PM₁₀, or particulate matter with approximately 10 µg diameter. The first standards for the more modern day air quality began with PM₁₀, and it was thought that Bend was close to exceeding the standard due to winter time smoke. The air in Bend, and later in Sisters, was monitoring for PM₁₀ concentrations. As more homes were built in all communities, and natural gas mostly available other than in outlying communities, and population density caused rethinking of ordinances such as allowing winter time burning and burn barrels, the winter time PM₁₀ levels were reasonably controlled. Since the late 90's, a standard for finer and more impactful particulate, PM_{2.5}, were promulgated, and revised downward in 2006 to more protective levels for human health.

Current Air Quality Monitoring

PM_{2.5} levels were first monitored in Bend, then in Sisters, and finally in 2019 in Redmond and in 2020 in La Pine. Other air quality monitoring networks have also appeared, from low cost home systems such as the Purple Air monitors and the e:space network throughout Central Oregon. The former are not calibrated and prone to higher readings of wood smoke (1.5 or higher times in value than a calibrated unit), giving people a false sense of alarm. The e:space network does undergo a calibration and correlation routine to be more reliable than the simple air quality monitors. The DEQ monitoring network must meet rigorous quality control and quality

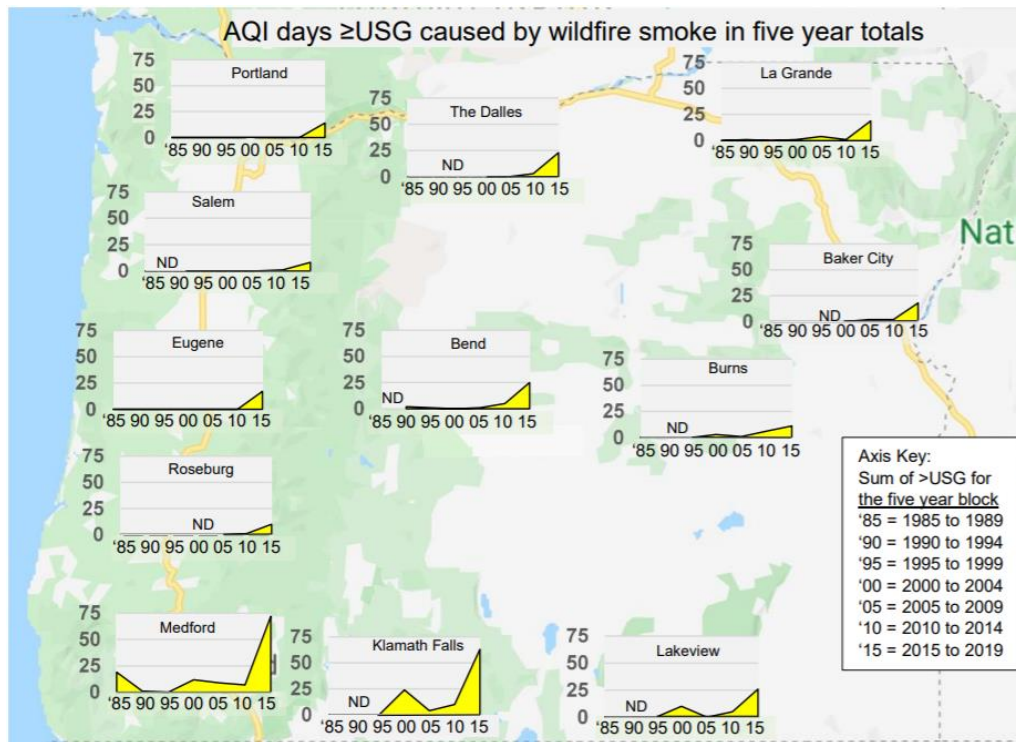
assurance routines accepted by the U.S. Environmental Protection Agency and included into national monitoring network. The current more widespread monitoring in the County, from all different AQ monitors, allows for the evaluation of where the PM2.5 levels are high and gives us trends or an indication of concentration of PM2.5 throughout the county.

While PM2.5 is under control for the most part during non-wildfire episodes, the current National Ambient Air Quality Standard for PM2.5 is subject to change and may be revised downward in the future from 35 ug/m3 in a 24 hour period to something lower which may initially be difficult for areas in the County to meet. Wildfire smoke, not being caused by regular human activity, is not counted against the communities in the critical evaluation of compliance with the NAAQS, but air quality is recognized as still degrading to levels that otherwise exceed the air quality standards and is not healthy for the residents during episodes of smoke.

Wildfire Smoke

Wildfire smoke is an emerging periodic health challenge to residents of Deschutes County. Besides the increasing trend of local fires, there is also an increasing trend of severe smoke impacts from other areas in Oregon, the Pacific Northwest, California, or even from British Columbia. This smoke has a trend of being more concentrated and having a longer duration, causing harm to the residents of the County.

Figure II-23 Map of Wildfire Air Quality Index trends across Oregon



Source: Barnack, A. (2020). (rep.). *Wildfire Smoke Trends and the Air Quality Index*. Portland, OR: Oregon Department of Environmental Quality

Health Impacts

Wildfire smoke contains many toxic gases, including polycyclic aromatic hydrocarbons (PAHs), and particulate matter. The particulate matter can be comprised of many smaller molecules joined together, and/or organic carbon molecules as a base. Wildfire smoke also contains high amounts of carbon monoxide which can be lethal when inhaled over a period of time or have other deleterious side effects. Carbon monoxide is mainly a concern to wildland fire fighters and those on the front line or very close to large fires.¹⁰

The particulate matter can be transported long distances or be present from nearby fires and is a focus of concern to health authorities (Oregon Health Authority, Department of Environmental Quality). Concentrations of fine particulate matter (PM_{2.5}) from wildfires readily exceed the National Ambient Health Standard of 35 µg/m³ for a 24-hour period. When exceeded for multiple days in a row, the regional health can be compromised unless prompt, effective, and continuous mitigation measures are employed.¹¹

Vulnerable populations are especially prone to having adverse impacts quickly from wildfire smoke. As defined in the Oregon Department of Forestry Rules, OAR 629-048: *“Vulnerable populations” means people with specific sensitivities including, but not limited to, those with heart diseases, coronary artery disease, congestive heart failure, or those with lung and respiratory diseases, such as chronic obstructive pulmonary disease (COPD), and those with asthma, older adults, pregnant women, and children.*

Such populations can be impacted by smoke from just an hour or more of elevated concentrations (such as above 25 µg/m³, 1 hour basis). This is because fine particulate matter enters and impacts the lungs but also the small particulates can enter the bloodstream through the lungs. The former is more of the immediate issue for people with breathing problems and respiratory conditions, but the latter can impact everyone over time and have carcinogenic impacts. The relationship between increases in smoke concentration and rates of morbidity is increasingly a topic of research due to concern over the health impacts of wildfire smoke.¹²

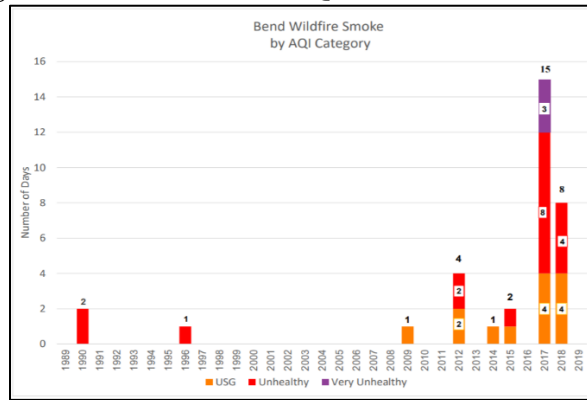
¹⁰ Oregon Health Authority, *Wildfires and Smoke*.

<https://www.oregon.gov/oha/PH/Preparedness/Prepare/Pages/PrepareForWildfire.aspx#health>

¹¹ Central Oregon Fire Info, *Smoke & Your Health*. <https://www.centraloregonfire.org/wildfire-smoke-your-health/>

¹² Oregon Department of Environmental Quality, *Air Quality Monitoring*. <https://www.oregon.gov/deq/aq/Pages/Air-Quality-Monitoring.aspx>

Figure II-24 Bend \geq USG AQI Wildfire Smoke Trends



Source: Barnack, A. (2020). (rep.). *Wildfire Smoke Trends and the Air Quality Index*. Portland, OR: Oregon Department of Environmental Quality

At times, all of Deschutes County can be blanketed in smoke. This is mostly when the smoke is coming from other areas and plumes are widespread. Local heavy impacts can occur from nearby fires, such as from the Pole Creek fire when Sisters was inundated with smoke, but Bend and further south was mostly not. Smoke from local fires tends to mostly impact down drainage sites or area in the predominant wind flow patterns, and can often not be as heavy for many hours in the day then degrade to unhealthy or worse conditions.¹³

Probability

The probability of wildfire smoke impacts are very difficult to predict, but Deschutes County and Central Oregon overall will likely experience widespread wildfire smoke in the near future. Some years there may be no smoke impacts, others with a few days, and others with smoke impacts for a week or longer in duration. Due to the number of forested areas in and around Deschutes County, and in the heavily forested Pacific Northwest and up into British Columbia, smoke from distant wildfires can impact this region.¹⁴

Mitigation

Mitigating impacts of smoke can vary from shorter-term impacts to longer duration incidents. For shorter term elevated concentrations, people are advised to stay inside or be outside only as necessary and for as little time as possible. Indoors, people are recommended to keep windows and doors closed, operate the air system on recirculation and use a HEPA filter if they have one, or operate an indoor air purifier with a HEPA filter.

For long term exposures, or when it is known the smoke will persevere for a few days or longer, there are a few options:

- Shelter in place and use HEPA level filters;
- Operate HVAC on recirculation mode;

¹³ Deschutes County NHMP Steering Committee members, 2021.

¹⁴ Ibid.

- Keep all windows and doors closed, possibly applying tape to leakier door frames or windows to keep air infiltration down;
- Use a draft block at the base of doors (a towel or draft snake as they can be called);
- Properly wear an N95 mask if one needs to go outside (people who should not wear N95's include children and people with certain medical conditions that may be exacerbated by mask-wearing);
- Limit any time spent outdoors to the minimum;
- Consider leaving the area for a location with clean air or not impacted by wildfire smoke. Sometimes this is out of state and many states distant.
- Operate multiple air purifiers in the home, possibly including Do-it-yourself air filtration systems using 20"x20" box fans with 1" filters of MERV 13 level as possible but even MERV 11 or 12 will help some.

Current tips and recommendations can be found on the Oregon Health Authority's (OHA) [webpages](#) for Wildfire Smoke.

Deschutes County Public Health has obtained some HEPA portable air filters and placed them in some of the public places where vulnerable people meet. Recommendations have been made to conduct surveys of air filtrations systems in places such as the school systems, County buildings, Senior Centers, Libraries and so forth to first know how each area is equipped to handle long term and short-term smoke events and where improvements need to be made. The goal is to make the County much more resilient to wildfire smoke and truly be a Smoke Ready Community. All citizens are being educated on the value of obtaining their own HEPA systems and having spare filters on hand to be able to endure a wildfire smoke event such as the one in September 2020.¹⁵

Existing Authorities, Policies, Programs, and Resources

Existing authorities, policies, programs, and resources include current mitigation programs and activities that are being implemented by city, county, regional, state or federal agencies and/or organizations.

Local fire prevention and hazardous fuels treatment efforts have been an integral component of the local interagency coordination picture since the early 1980's. The challenge of an expanding wildland urban interface was recognized in Deschutes County two decades ago. The local fire service response system reflects that long period of interface fire experience and the recognized value of pre-incident mitigation activities.

County and Cities

Project Impact

Deschutes County was designated an Oregon Project Impact community in 1999. At the time, this national-level program was established "to reduce the human and economic costs of disasters through prevention, preparation and mitigation." Deschutes County was one of only a

¹⁵ Deschutes County Public Health, <https://www.deschutes.org/health/page/health-tips-wildfire-smoke>. Accessed May 2021.

few areas across the nation identified to focus on wildland fire related mitigation activities. A steering committee was established by the Deschutes County Board of Commissioners to provide oversight and accountability for use of the funds. The original \$300,000 grant allowed Project Impact to construct an additional escape route out of an at-risk community and fund additional activities for the next three years.

In 2002, a consultant and a sub-group of the steering committee began to explore development of a business plan for a follow-on organization to Project Impact. Project Wildfire was established. Based on the foundation of the Project Impact experience and as stated previously, Project Wildfire continues to provide coordination of a variety of wildland fire mitigation activities including the FireFree program, the facilitation of the 7 Community Wildfire Protection Plans, serves as a source of wildfire mitigation and preparedness information for local groups, and secures grant funding to support fuel mitigation activities in local at risk communities.

FireFree

The FireFree program is a nationally recognized model for homeowner education and mitigation programs in the wildland urban interface. Created in 1997 following the devastating Skeleton Fire in Bend, FireFree creates awareness and educates residents about the risks of wildland fire to homes and property and the ten simple steps they can take to reduce those risks. FireFree encourages homeowners to take responsibility for risk mitigation by creating defensible space around their property and disposing of debris. To find the ten FireFree steps, the FireFree program has an established website www.firefree.org.

FireFree is the local grass root, call-to-action program in Deschutes County for residents to prepare their property for wildfire. The FireFree events culminate every spring and fall with FireFree community clean up days where residents can dispose of their yard debris created by maintaining or creating defensible space, for free at surrounding disposal sites. FireFree is coordinated by Project Wildfire as a collaborative effort among local fire agencies, forestry departments, private businesses and the insurance industry.

Project Wildfire

Project Wildfire is the result of a Deschutes County effort to create long-term wildfire mitigation strategies and provide for a disaster-resistant community. Its mission is to prevent deaths, injuries, property loss and environmental damage resulting from wildfires in Deschutes County. Created by Deschutes County Ordinance 8.24.010, Project Wildfire is the community organization that facilitates, educates, disseminates and maximizes community efforts toward effective fire planning and mitigation. Project Wildfire is governed by a 27-member steering committee that is defined by County Ordinance 8.24.020 as a 50-50 balanced mix between fire agency representatives, private residents, elected officials, Deschutes County 911, Deschutes County Emergency Management, Insurance, and many other at large community members.

Project Wildfire has established a web site (www.projectwildfire.org) to help showcase the wide variety of hazardous fuels treatment, prevention projects, and public information and educational opportunities.

Wildland and Structural Fire Services Program Coordination

Both wildland and structural fire agencies provide a range of services including:

- educational and prevention services;
- pre-season planning and incident response consistent with statutory, jurisdictional and regulatory responsibility; and
- fire response on private and public lands within Deschutes County.

Fire agencies in central Oregon have responded to expanding community development, increasing population and increasing wildland urban interface fire load (risk) by developing a well-coordinated structural and wildland response system.

A formal Central Oregon Cooperative Wildland Fire Agreement exists among wildland and structural fire agencies. While wildland fire agencies are funded to address wildland fire issues there are statutory and agency-specific limitations to expending dedicated firefighting funds for “all risk” incidents. During a Declaration of Emergency, wildland fire agencies can be partially reimbursed through the federal response framework.

Central Oregon Fire Chiefs Association

The Central Oregon Fire Chiefs Association (COFCA) provides a formal forum for fire chiefs in Crook, Deschutes, Bureau of Indian Affairs (BIA), and Jefferson counties to integrate any refinements to the interface fire response system for their individual structural and wildland agencies. COFCA also provides the leadership umbrella for a variety of local interagency prevention, investigation and training groups.

Wildland Fire Prevention

Central Oregon wildland and structural fire services have a long tradition of effective organization-specific and cooperative programs. In dry, fire-prone regions such as central Oregon, fire prevention programs address two facets of preventing destructive wildfires: 1) ignition prevention, and 2) large, catastrophic fire prevention.

An example of a cooperative ignition prevention effort is the Central Oregon Fire Prevention Cooperative (COFPC). This effort was organized in 1978 to provide a forum for coordination of common fire prevention needs between the state and federal wildland fire agencies and structural fire service agencies in Crook, Deschutes, Bureau of Indian Affairs (BIA) and Jefferson counties. COFPC provides a mechanism to maximize effective use of staffing and fiscal resources from all of the cooperating agencies. Its purpose is to conduct a wide variety of ignition prevention, youth education, public service and public education initiatives. COFPC remains active today and has received state, regional and national recognition for its efforts.

The second category includes activities intended to mitigate the impact of large fires. Examples focus on broad hazardous fuels treatment strategies to keep fires at more manageable levels and the development of defensible space around individual homes. There are a variety of local programs currently active and several more in the developmental stage throughout the county.

In Deschutes County, Project Wildfire is a successful example of a collaborative approach to large wildland fire mitigation. A national leader and model for wildland fire mitigation; Project

Wildfire takes advantage of public and private partnerships and collective resources to prevent deaths, injuries, property loss and environmental damage from wildland fire.

In recent years, Project Wildfire has become the facilitator and “caretaker” of seven Community Wildfire Protection Plans and the coordinator of the FireFree Program. Project Wildfire succeeds where an individual or one agency cannot. Project Wildfire is also committed to developing wildland fire prevention and education strategies and implementing hazardous fuels reduction programs across the County.

Community Wildfire Protection Plans

Through the CWPP process, the overwhelmingly clear answer to the wildland fire mitigation question is to reduce the potential for extreme fire behavior by reducing the amount of hazardous fuels in high risk areas on both public and private lands. Since the inception of CWPPs, Deschutes County has secured approximately \$6 million in funding under the National Fire Plan, Western States and FEMA grant programs to educate communities and treat hazardous fuels in and around communities at risk.

The wildland fire mitigation efforts in Deschutes County span a variety of agencies and groups. The County has facilitated treatment on over 2,000 acres of hazardous vegetation on private lands each year since 2005. While this number does not sound significant on the surface, it is rather formidable when one considers that these fuels treatments were achieved on private properties $\frac{1}{4}$ to $\frac{1}{2}$ acres at a time. Since Project Wildfire’s establishment in 1999, over 110,000 acres have been treated within and around communities. Complimentary Federal Land projects more than double this figure.

The CWPPs identified priority Communities at Risk and the US Forest Service has responded by treating national forest land in the WUIs since 2005.

These successful projects; however, are also due in part to the level of collaboration experienced in Deschutes County. As stated earlier, Project Wildfire and the CWPP Committees and other groups such as the Nature Conservancy’s Fire Learning Network and Central Oregon Intergovernmental Council routinely engage community members from all areas concerned about wildland fire. This includes representatives from the timber industry as well as environmental groups. It is not uncommon to see Timber Industry Consultants at the same planning table as Sierra Club members. This collaborative approach to fuels management on public lands includes all interested parties from the beginning. The results we continue to see in central Oregon are broadly accepted fuels treatment projects that proceed without litigation and protest.

Deschutes County is also home to one of the first ten funded Collaborative Forest Landscape Restoration projects, which is restoring the federal forest to a more resilient condition while improving the fuel conditions in the WUI. Called the Deschutes Collaborative Forest Project (DCFP).

The CWPPs for Deschutes County can be found at www.projectwildfire.org

Emergency Operations Plans

The county and cities have Emergency Operations Plans (EOPs). The EOPs describe how the jurisdictions will organize and respond to emergencies and disasters. The plans include specific information related to wildfires.

Rangeland Fire Protection Associations

Rangeland Fire Protection Associations (RFPAs) provide wildfire protection of private land within Deschutes County. RFPAs (formed under ORS 477.315) protect over 3.2 million acres of private land in eastern Oregon with support from the Oregon Department of Forestry (ODF). RFPAs operate as independent associations of landowners that provide their own protection with the support of the ODF (chiefly technical support for grants, grant writing, procurement of equipment and firefighting training).¹⁶ The ODF provides a small source of funding for the RFPAs, however, the majority of funds come from federal grants (primarily Volunteer Fire Assistance and Rural Fire Assistance). Additional fees are collected from voluntary membership dues. The RFA has a responsibility to protect private lands of members and non-members alike per the agreement formed with ODF when the RFA is formed.

The following two RFPAs are active within Deschutes County:

- Brothers-Hampton RFA (established 2006)
- Post-Paulina RFA (established 2006)

State

In part because of Deschutes County's 1990 Awbrey Hall Fire, the 1993 State Legislature initiated a process to identify wildfire hazard and declare wildfire hazard zones. The legislation provided a mechanism for counties to supersede local provisions requiring the use of flammable roofing materials such as wood shake. A second provision requires that addresses of structures be clearly identified. This process is complete in Deschutes County with the implementation of provisions in the Deschutes County Building Code. This is of particular significance because a combustible roof is the most vulnerable structure component to ember attack in interface wildfire situations. By Deschutes County Ordinance, installation of combustible roofing materials is no longer allowed on new structures or replacement roof systems.

The Oregon Forestland-Urban Interface Fire Protection Act of 1997 (Senate Bill 360)

Administered by the Oregon Department of Forestry (ODF), Senate Bill 360 enlists the aid of property owners toward the goal of turning wildland urban interface properties into less volatile zones where homes can survive and firefighters may more safely and effectively defend them against wildland fire. Senate Bill 360 applies only to interface areas on private land within the boundary of an Oregon State Department of Forestry District.

¹⁶ Foster, Gordon. Oregon Department of Forestry. "Status of Rangeland Fire Protection Associations". 2011. <http://www.oregon.gov/odf/fire/fpfc/rfawhite.pdf>. Accessed March 2013.

The law requires property owners in identified areas to reduce excess vegetation around structures and along driveways. In some cases, depending on the rating classification of the property, it is also necessary to create additional fuel breaks along property lines and roadsides.

The process of identifying wildland urban interface areas follows steps and definitions described in Oregon Administrative Rules. Briefly, the identification criteria include:

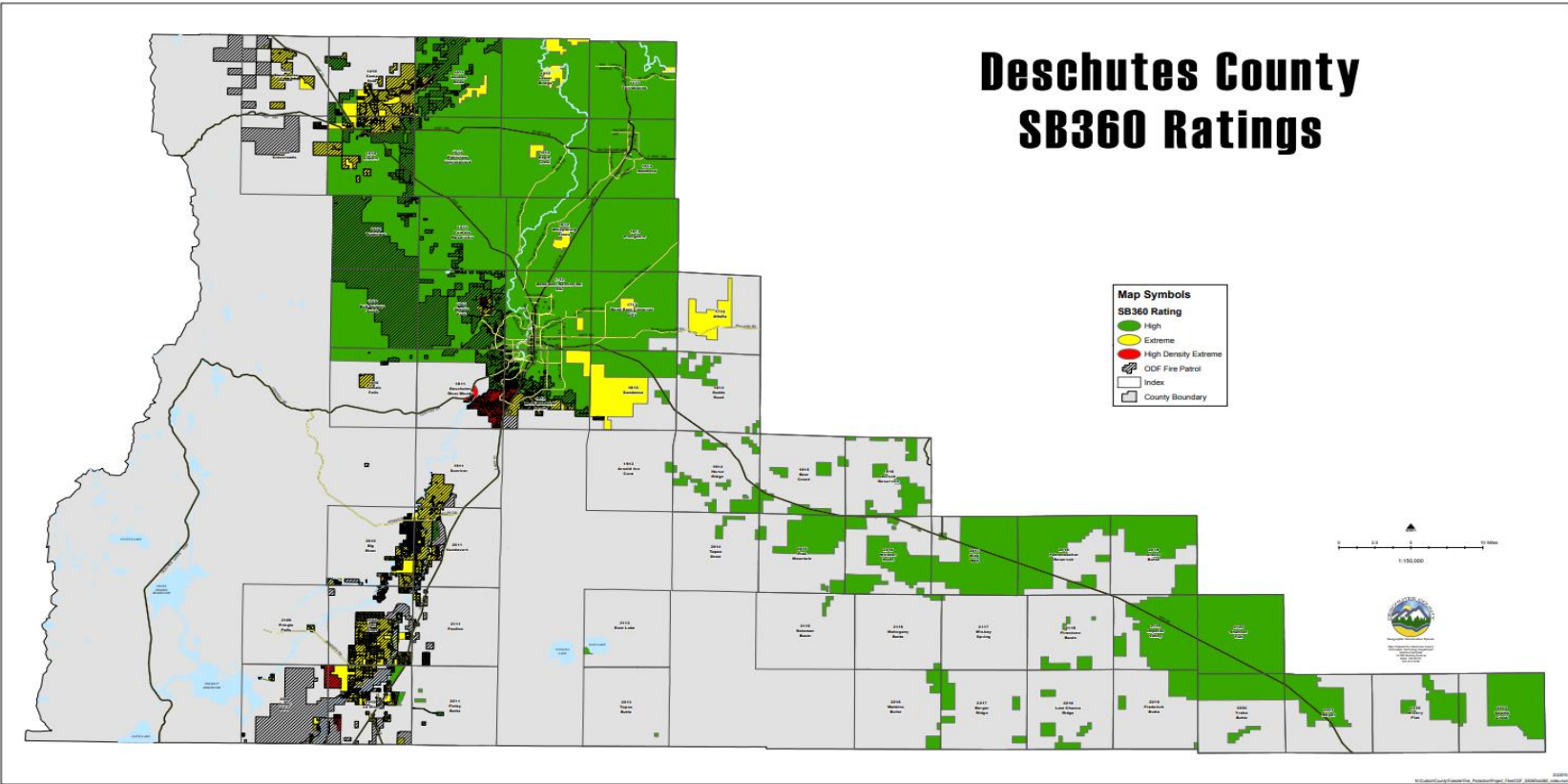
- Lands within the county that are also inside an Oregon Department of Forestry protection district.
- Lands that meet the state's definition of "forestland."
- Lands that meet the definition of "suburban" or "urban"; in some cases, "rural" lands may be included within a wildland urban interface area for the purpose of maintaining meaningful, contiguous boundaries.
- Lots that are developed, 10 acres in size or smaller, and which are grouped with other lots with similar characteristics in a minimum density of four structures per 40 acres.

A classification committee identified wildland urban interface areas in each county where Senate Bill 360 is applied. Once areas are identified, a committee applies fire risk classifications to the areas. The classifications range from "low" to "high density extreme," and the classification is used by a property owner to determine the size of a fuel break that needs to be established around a structure. The classification committee reconvenes every five years to review and recommend any changes to the classifications.

The Oregon Department of Forestry is the agency steward of this program. It supplies information about the act's fuel reduction standards to property owners. ODF also mails each of these property owners a certification card, which may be signed and returned to ODF after the fuel reduction standards have been met. Certification relieves a property owner from the act's fire cost recovery liability. This takes effect on properties that are within a wildland urban interface area and for which a certification card has not been received by the Department of Forestry. In these situations, the state of Oregon may seek to recover certain fire suppression costs from a property owner if a fire originates on the owner's property, the fuel reduction standards have not been met, and ODF incurs extraordinary suppression costs. The cost-recovery liability under the Oregon Forestland- Urban Interface Fire Protection Act is capped at \$100,000.

In Deschutes County, Senate Bill 360 Ratings fall into High, Extreme and High-Density Extreme categories (see Figure II-22 below). The provisions of Senate Bill 360 also contain Optional Standards to accommodate a variety of circumstances and landowner preferences. Additional fuel breaks along property lines and roadsides are required for those properties that fall under the Extreme and High Density Extreme ratings.

Figure II-25 Deschutes County SB 360 Ratings



Source: Deschutes County Forester, 2021

Each of the Community Wildfire Protection Plans incorporates Senate Bill 360 ratings where appropriate to provide additional risk assessment information. It also incorporates the Senate Bill 360 standards when listing recommendations for defensible space and fuel breaks on private property:

- A minimum 30-foot primary fuel break around structures for properties rated High. Up to an additional 70 feet of fuel breaks are required depending on rating and roof composition. A fuel break consists of: Removal of dead/dry/flammable brush around home, roof, chimney, decks and under nearby trees; removal of low hanging branches on trees; and reposition of wood piles at least 20 feet away from home during fire season.
- A minimum fuel break of 12 feet wide and 13.5 feet tall along driveways are also required if they are over 150 feet long.

Federal

In 2002, President George Bush established the Healthy Forests Initiative (HFI) to improve regulatory processes to ensure more timely decisions, greater efficiency and better results in reducing the risk of high intensity wildfire. This initiative allowed forest management agencies for the first time, to expedite the environmental compliance process for the purpose of reducing hazardous fuels on public lands.

In 2003, the US Congress passed historical bi-partisan legislation: the Healthy Forests Restoration Act (HFRA). This legislation expands the initial effort under the Healthy Forests Initiative and directs federal agencies to collaborate with communities in developing a Community Wildfire Protection Plan (CWPP), which includes the identification and prioritization of areas needing hazardous fuels treatment. It further provides authorities to expedite the National Environmental Policy Act (NEPA) process for fuels reduction projects on federal lands. The act also requires that 50% of funding allocated to fuels projects be used in the wildland urban interface.¹⁷

At the time of compiling data, resources and information for the 2005 Natural Hazard Mitigation Plan, HFRA was new on the scene and the complete impact of its legislative reach was unknown.

As a result of the authorities under HFRA, communities in Deschutes County now have the opportunity to participate in advising where federal agencies place their fuels reduction efforts. With a Community Wildfire Protection Plan in place, community groups can apply for federal grants to treat hazardous fuels and address special concerns to reduce the risk of catastrophic loss as a result of wildland fire.

Although some of the authorities under the Healthy Forests Initiative have been subsequently challenged in federal courts, all have been successfully appealed and the original intent and authorities under each remain the same.

As the Deschutes County CWPPs are revised, the plans now include specific language regarding the National Cohesive Fire Management Strategy. In 2009, Congress passed the Federal Land Assistance, Management, and Enhancement (FLAME) Act and called for a National Cohesive

¹⁷ "Healthy Forests Restoration Act of 2003" (H.R. 1904); One Hundred Eighth Congress; Administrative implementation information available at www.fireplan.gov.

Wildland Fire Management Strategy to address wildland fire related issues across the nation in a collaborative, cohesive manner. The Cohesive Strategy was finalized in 2014 and represents the evolution of national fire policy:

“To safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a Nation, live with wildland fire.”

The primary, national goals identified as necessary to achieving the vision are:

Resilient landscapes: Landscapes across all jurisdictions are resilient to fire-related disturbances in accordance with management objectives.

Fire-adapted communities: Human populations and infrastructure can withstand a wildfire without loss of life and property.

Wildfire response: All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions.

Hazard Mitigation Action Items

There are four identified wildfire action items for Deschutes County; in addition, several of the Multi-Hazard action items affect the wildfire hazard. An action item matrix is provided within Volume I, Section 3, while action item forms are provided within Volume IV, Appendix A. To view city actions, see the appropriate city addendum within Volume III.

Significant Changes since the 2015 Plan

Significant changes to this section include an updated definition of a windstorm and history of significant windstorms in 2020, a new section on Future Climate Variability, updated wind speed category, new information on wind conditions in relation to fire and damage, and additions to Causes & Characteristics. Tables II-13 and 14 were updated as well.

Causes and Characteristics of the Hazard

Extreme winds occur throughout Oregon. 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. East winds can, however, create unusually volatile fire weather environments, especially through the Cascades. Additionally, if winds are fairly strong from the east/ northeast, the unusual wind direction can topple trees and other vegetation that is not used to/rooted for such winds.

Winds associated with thunderstorms are short-lived, but strong winds not associated with thunderstorms can last several hours. Although windstorms can affect the entirety of Deschutes 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.

Though tornadoes are not common in Oregon, these events do occasionally occur and sometimes produce significant property damage and even injury. Tornadoes are the most concentrated and violent storms produced by earth's atmosphere, and can produce winds in excess of 300 mph. They have been reported in most of the counties throughout the state since 1887. Most of them are caused by intense local thunderstorms common between April and October. While tornadoes can result in much more severe damage than straight line winds, the damage is usually confined to a narrow path of a quarter mile or less. Damaging straight line winds pose a greater risk as they occur more frequently and over a broader area.

History of Windstorms in Deschutes County

The Columbus Day storm in 1962 was the most destructive windstorm ever recorded in Oregon in terms of both loss of life and property. Damage from this event was the greatest in the Willamette Valley, where the storm killed 38 people and left over \$200 million in damage. Windstorms occur yearly; more destructive storms occur once or twice per decade. The following table shows windstorms that have affected Deschutes County between 1951 and 2020.

Table II-13 Partial History of Significant Windstorms (1951 to 2020)

Date	Affected Area	Comments
Nov., 1951	Statewide	Widespread damage, transmission and utility lines, wind speeds 40-60 mph, gust 75-80 mph
Dec., 1951	Statewide	Wind Speed up to 60 mph in Willamette Valley, 75 mph gusts; damage to building and utility lines.
Dec., 1955	Statewide	Wind speeds 55-65mph, with 69 mph gusts. Considerable damage to buildings and utility lines.
Nov., 1958	Statewide	Wind speeds up to 51 mph, with 71 mph gusts. Major highways blocked by fallen trees.
Oct., 1962	Almost all of Oregon	Oregon's most famous and most destructive windstorm, the Columbus Day Storm, produced a barometric pressure low of 960 mb
Mar., 1971	Most of Oregon	Storm center moved into NW Washington, bringing cold front heading east and damaging winds on March 26.
Nov., 1981	Pacific Northwest	Back-to-back storms on the 13th and 15th of November
Jan., 1990	Statewide	Severe windstorm
Dec., 1991	NE and Central Oregon	Severe windstorm
Dec., 1995	Statewide	Strongest windstorm since Nov. 1981; barometric pressure of 966.1 mb at Astoria, and an Oregon record low 953 mb off the coast; major disaster declaration FEMA-1107-DR-OR
Apr., 2003	Deschutes County	\$10,000 in property damage
Nov., 2003	Deschutes County	\$2,000 in property damage
Oct., 2005	Central Oregon	A strong wind gust blew a Ponderosa Pine tree over onto a home in southeast Bend. The property damage from this event is estimated at \$50,000
Nov., 2005	Central Oregon	A strong wind gust blew over a Ponderosa Pine Tree which fell on two mobile homes causing extensive damage at Sisters Mobile Home Park. The property damage from this event is estimated at \$40,000.
Jun., 2006	Jefferson, Deschutes, Crook Counties	Strong winds and hail caused \$7 million in insurance claims for damage to automobiles and homes
Oct., 2007	Central Oregon	A cold front brought strong winds with gusts 40-50 mph which knocked down trees and power lines in Sisters. One tree fell onto a house.
Jan. 1, 2009	Central Oregon	A downslope windstorm generated high winds with gusts between 65 and 70 mph in and around Bend and other Central Oregon locations.
Mar. 31, 2009	Central Oregon	A strong low pressure system brough high winds to areas east of the Cascades. Wind gusts of 70-75 mph occurred north of Sisters with damage to trees, power lines, and blowing dust.
May 3, 2010	Central Oregon	Damaging winds toppled trees and power lines in the Bend area.
Nov. 22, 2011	Central Oregon	A strong storm system brought damaging winds that toppled trees and power lines in the Bend and Sisters area, and forced the closure of Shevlin Park.
Nov. 19, 2012	Central Oregon	Widespread strong winds toppled several trees in the Bend area, knocking down several trees and power lines.
May 4, 2013	Deschutes County	Strong winds brought down numerous trees and some power lines, resulting in a fast moving grass fire that burned 160 acres.
Jan. 11, 2014	Deschutes County	High winds with a strong cold front resulted in downed trees and power lines with outages affecting over 10,000 people. Wind gusts were measured around 60 mph.
Dec. 11, 2014	Central Oregon	A powerful storm system generated downslope winds of 60 mph, resulting in downed trees and power lines around the Bend and Redmond areas.
Feb. 6-9, 2015	Central Oregon	Two wind events occurred back to back, one associated with a warm front on the 6th, and another on the 9th associated with a downslope wind storm off the Cascades. In both instances, wind gusts of 55-60 mph occurred across parts of Deschutes County, damaging trees and power lines.
Nov. 17, 2015	Central Oregon	A strong low pressure system brought wind gusts of 60 to 65 mph to the region.
Dec. 7, 21, 2015	Central Oregon	A downslope wind event onthe 7th brought 60 mph winds, downing several trees and causing power interruptions. On the 21st, winds of 60-65 mph were felt in Deschutes county with a measured gust to 64 mph at the Redmond Airport. Tree damage was also reported at Tumalo.

Table II-13 Partial History of Significant Windstorms (1951 to 2020) cont.

Date	Affected Area	Comments
Dec. 19, 2017	Deschutes County	A strong cold front brought damaging wind gusts to Deschutes County. Numerous trees and power lines were affected in and around Bend, resulting in power loss to around 2000 people.
Feb. 17, 2018	Deschutes County	A powerful storm system brought damaging wind gusts to portions of Deschutes County. A wind gust of 66 mph was recorded 1 mile NNE of Sisters with at least one large tree blown down.
Aug. 9, 2019	Deschutes County	Thunderstorms produced quarter sized hail and wind gusts to 60 mph, leading to minor roof damage on the west side of Redmond.
Feb. 23, 2020	Deschutes County	A strong cold front brought intense winds to much of Central Oregon. Winds of 45 to 55 mph were common with the stronger gusts around 60 mph affecting Bend. Downed trees and lines resulted in power outages and some minor damage to homes and vehicles.
May 30, 2020	Deschutes County	A significant severe thunderstorm moved from south to north on the west side of highway 97. The storm brought hail to the size of golfballs to baseballs and damaging straight line winds of 70 to 90 mph. The winds downed numerous trees and power lines, resulting in some structural damage as well.

Sources: Oregon State Natural Hazard Mitigation Plan 2020; Taylor, G.H. and Hatton, R.R., 1999; The Oregon Weather Book, A State of Extremes: Corvallis, Oregon, Oregon State University Press; NOAA Storm Events Database <http://www.ncdc.noaa.gov/stormevents/>. Accessed April 2021.

Future Climate Change Variability

Research into current links between climate change and wind are ongoing, but results and/or data into these studies may still be a few years out.

Hazard Identification

Windstorms can affect developed areas of the county with significant tree stands and major infrastructure, especially above ground utility lines. The lower wind speeds typical of eastern Deschutes County can still be high enough to knock down trees and power lines, and cause other property damage.

As of the 2014 Oregon Residential Specialty Code, Oregon Basic Wind Speeds for 50 Year Mean Recurrence Interval, Deschutes County is listed within the lowest wind speed category as an area impacted by 65 mph area wind speeds.

For winter weather events (including high winds,) the National Weather Service monitors gauging stations and provides public warnings for storms and high winds.

Windstorms in Deschutes County usually occur from October to March, and their extent is determined by their track, intensity (the air pressure gradient they generate), and local terrain.¹ The National Weather Service uses weather forecast models and local and regional observations

¹ 2020 Oregon Natural Hazard Mitigation Plan. Department of Land Conservation and Development, 2020.

to predict oncoming windstorms, while monitoring storms with weather stations in protected valley locations throughout Oregon.²

Extreme weather events are experienced in all regions of Oregon. The regions that experience the highest wind speeds are in the Central and North Coast of Region 1. 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 Deschutes County, within Region 6, can expect to be exposed to lower wind speeds than most regions within the state.

Table II-14 Probability of Severe Wind Events by NHMP Region

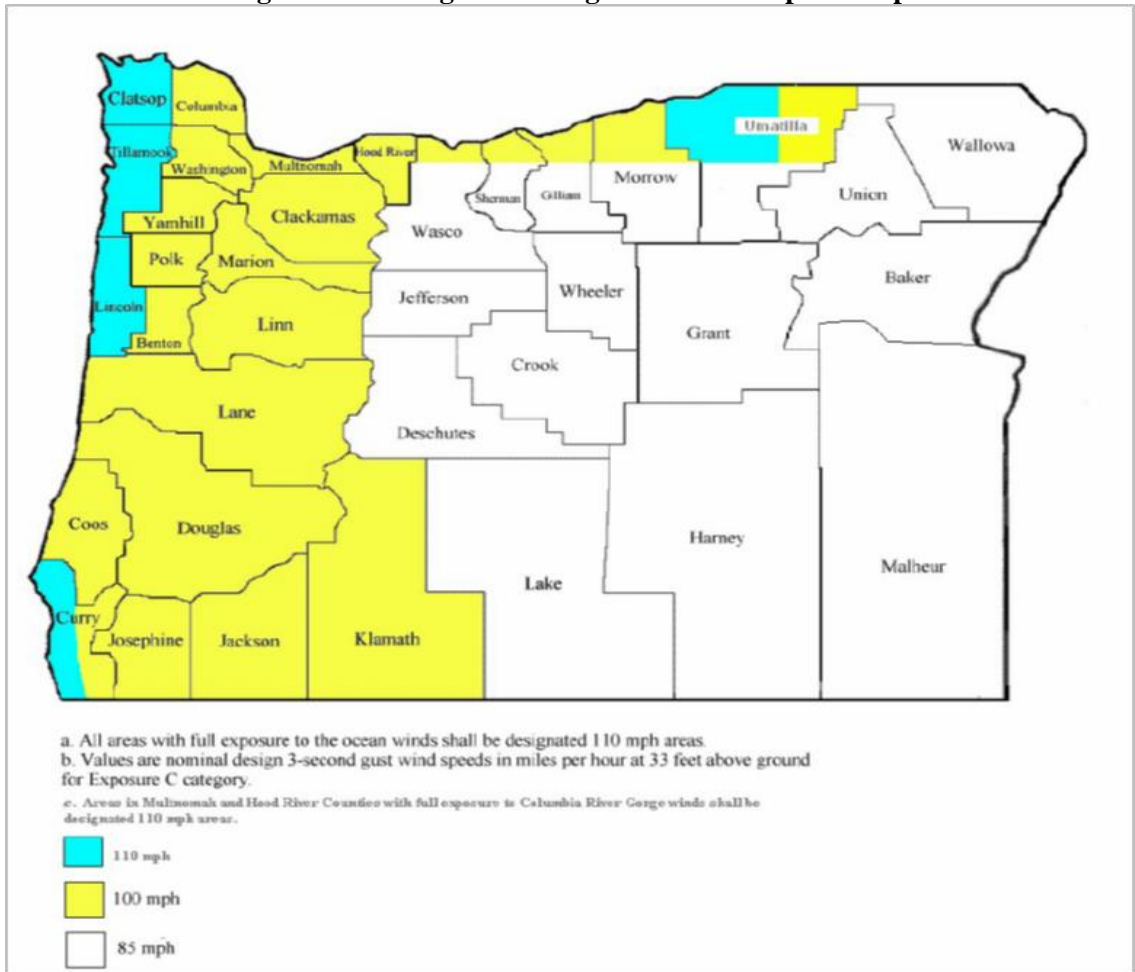
	25-Year Event (4% annual probability)	50-Year Event (2% annual probability)	100-Year Event (1% annual probability)
Region 1: Oregon Coast	75 mph	80 mph	90 mph
Region 2: North Willamette Valley	65 mph	72 mph	80 mph
Region 3: Mid/Southern Willamette Valley	60 mph	68 mph	75 mph
Region 4: Southwest Oregon	60 mph	70 mph	80 mph
Region 5: Mid-Columbia	75 mph	80 mph	90 mph
Region 6: Central Oregon	60 mph	65 mph	75 mph
Region 7: Northeast Oregon	70 mph	80 mph	90 mph
Region 8: Southeast Oregon	55 mph	65 mph	75 mph

Source: Oregon State Natural Hazard Mitigation Plan, 2020

Figure II-23 visualizes the maximum wind speed that structures 33 feet above the ground would expect to be exposed to; for Deschutes County that expected wind speed is less than most of the state at 85 mph.

² "Some of the Area's Windstorms." National Weather Service, Portland.
<https://www.wrh.noaa.gov/pqr/paststorms/wind.php>

Figure II-26 Oregon Building Codes Wind Speed Map



Source: Oregon Residential Specialty Code, 2014.

Probability Assessment

Windstorms affect Deschutes County on nearly a yearly basis. More destructive storms occur once or twice per decade. According to the State NHMP Region 6 – Central Oregon where Deschutes County is located is likely to experience windstorms of 60 mph during a 25-year cycle. It should be noted that some of the report incidents are localized events that do not affect large areas of the county or cities.

Deschutes County’s Natural Hazards Mitigation Steering Committee believes that the County’s **probability of experiencing a windstorm event is “high,”** meaning one incident is likely within the next 10 – 35 year period. Based upon available information, the Oregon NHMPs Regional Risk Assessment supports this probability rating for Deschutes County.³

³ 2020 Oregon Natural Hazard Mitigation Plan. Department of Land Conservation and Development, 2020.

Vulnerability Assessment

Many buildings, utilities, and transportation systems within Deschutes 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 Deschutes County, trees are more likely to blow over during the winter (wet season). Also, irrigation wheel lines frequently get tangled in windstorms, and ultimately affect the agriculture economy.

The Deschutes County Natural Hazards Steering Committee rated Deschutes County as having a **“moderate” vulnerability to windstorm hazards**; meaning between one and ten-percent of the region’s population or assets would be affected by a major emergency or disaster (particularly if utility lines are damaged). Based upon available information the Oregon NHMPs Regional Risk Assessment rates Deschutes County’s vulnerability to windstorms as “low”.⁴

Risk Analysis

The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section), and (2) the likelihood or probability of the harm occurring. Table 2-6 of the Risk Assessment (Volume I) shows the county’s Hazard Analysis Matrix which scores each hazard and provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard. Based on the matrix the **windstorm hazard is rated #3, out of 9 rated hazards, with a total score of 210.**

Community Hazard Issues

The damaging effects of windstorms may extend for distances of 100 to 300 miles from the center of storm activity. Positive wind pressure is a direct and frontal assault on a structure, pushing walls, doors, and windows inward.

Negative pressure also affects the sides and roof: passing currents create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact and remove the building protective envelope (doors, windows, and walls), internal pressures rise and result in roof or leeward building component failures and considerable structural damage.

⁴ Ibid.

Windstorms can result in collapsed or damaged buildings, damaged or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Roads blocked by fallen trees during a windstorm may have severe consequences to people who need access to emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted.

Historically, falling trees have been the major cause of power outages in Deschutes County. Overhead power lines can be damaged even in relatively minor windstorm events.

Industry and commerce can suffer losses from interruptions in electric service and from extended road closures. They can also sustain direct losses to buildings, personnel, and other vital equipment. There are direct consequences to the local economy resulting from windstorms related to both physical damages and interrupted services.

Windstorms can be particularly damaging to manufactured homes and other non-permanent housing structures, which, in 2012, accounted for 9.1% of the housing units in Deschutes County, special attention should be given to securing these types of structures.

More information on this hazard can be found in the Regional Risk Assessment for Region 6 of the Oregon NHMP.

Existing Authorities, Policies, Programs, and Resources

Existing authorities, policies, programs, and resources include current mitigation programs and activities that are being implemented by city, county, regional, state or federal agencies and/or organizations.

County and Cities

The county, cities, and utility districts routinely maintain hazard trees to keep utility lines and other infrastructure safe from damage in wind events.

State

The Oregon Building Code (both residential and other codes) sets standards for structures to withstand 80 mph winds. It is based on the International Residential Code and the International Building code.

Existing strategies and programs at the state level are usually performed by Public Utility Commission (OPUC), Building Code Division (BCD), Oregon Department of Forestry (ODF), Oregon Emergency Management (OEM), Oregon Department of Transportation (ODOT), and the Oregon Emergency Response System (OERS), who all have vital roles in providing windstorm warnings statewide.

The Public Utility Commission ensures the operators manage, construct and maintain their utility lines and equipment in a safe and reliable manner. These standards are listed on the following website: <http://www.puc.state.or.us/PUC/safety/index.shtml>

The OPUC promotes public education and requires utilities to maintain adequate tree and vegetation clearances from high voltage utility lines and equipment.

Oregon Emergency Management strives to reduce any damage and impacts caused by windstorms by working in partnership with PUC, ODOT, and the NWS. ODF promotes mitigation strategies and programs that reduce tree-caused damage to utility systems and highway corridors.

Federal

FEMA has recommended having a safe room in homes or small businesses to prevent residents and workers from “dangerous forces” of extreme winds to avoid injury or death. This recommendation is provided through FEMA’s resource manual: *Taking Shelter from the Storm*.⁵

Hazard Mitigation Action Items

There are no Windstorm action items for Deschutes County as of 2021; however, several of the Multi-Hazard action items affect the Windstorm hazard. An action item matrix is provided within Volume I, Section 3, while action item forms are provided within Volume IV, Appendix A. To view city actions, see the appropriate city addendum within Volume III.

⁵ <http://www.fema.gov/safe-room-resources/fema-p-320-taking-shelter-storm-building-safe-room-your-home-or-small-business>

WINTER STORM

Significant Changes since the 2015 Plan

Partners with the National Weather Service provided updated information for table II-15, history of winter storms. Additionally, minor formatting changes occurred.

Causes and Characteristics of Winter Storms

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. Deschutes County is primarily located within Zone 7: South Central Area, south and western portions of the county are located within Zone 5: High Plateau. The climate in Zone 7 generally consists of wet winters and dry summers.¹ These wet winters result in potentially destructive winter storms that produce heavy snow, ice, rain and freezing rain, and high winds. Severe storms affecting Oregon with snow and ice typically originate in the Gulf of Alaska or in the central Pacific Ocean. Winter storms occur over eastern Oregon regularly during November through February.² Cold arctic air sinks south along the Columbia River basin, filling the valleys with cold air.³

Figure II-26 Oregon Climate Divisions



Source: Oregon Climate Service

The principal types of winter storms that occur in Deschutes County include:

¹ Oregon Climate Service, “Climate of Deschutes County,”

² Oregon State Natural Hazards Mitigation Plan “Winter Storms Chapter”, 2020

³ Ibid

Snow Storm

Snowstorms require three ingredients: cold air, moisture, and an upper or lower level storm system. The result is snow, small ice particles that fall from the sky. In Oregon, the further inland and north one moves, or the higher in elevation, the more snowfall can be expected. Blizzards are included in this category.

Ice Storms

Ice storms are a type of winter storm that forms when a layer of warm air is sandwiched by two layers of cold air. Frozen precipitation melts when it hits the warm layer, and refreezes when hitting the cold layer below the inversion. Ice storms can include sleet (when the rain refreezes before hitting the ground) or freezing rain (when the rain freezes once hitting the ground).

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.

History of Winter Storms in Deschutes County

Destructive storms producing heavy snow, ice and cold temperatures occurred throughout the County's history, most notably in 1916, 1920, 1937, 1950, 1985, 1986, 1988, 1990, 1992-93 and the winter of 1998-99. More recently, the winters of 2010-11, 2013-14, 2016-17, and 2019 were especially active with numerous winter storm occurrences. All of these active storm years were marked by drifting snow and cold temperatures. Records also indicate people and communities were generally prepared and equipped to cope with the extreme weather conditions.

The severe winter storm of 1950 impacted the entire state of Oregon. While many places experienced high winds, cold weather and snow, the impact in Deschutes County was high snowfall and drifts. Transportation of supplies imported to the Deschutes Basin was limited. In general, Deschutes County and the region are well prepared for severe winter storms thus reducing the impact of inclement weather.⁴ The most significant storms which have affected Deschutes County and neighboring counties are listed below:

⁴ Taylor, George H. and Hannan, Chris, The Oregon Weather Book, (1999) Oregon State University Press.

Table II-15 Significant Winter Storm History for Deschutes and Nearby Counties

Date	Location	Event	Comments
Dec. 22, 1861	Pacific Northwest	Snowstorm Cold Weather	Very snowy winter; temperatures ranged from 0°F to -30° F. Over ten thousand cattle in eastern Oregon and Washington starved to death. Storm produced between 1 and 3 feet of snow.
Jan. 11-15, 1916	Entire State	Snowstorm	Two storms. Heavy snowfall, especially in mountaneous areas; coldest winter on record since record keeping began.
Dec. 15-16, 1924	Entire State	Cold Weather	Coldest December on record at the time; Drewsey and Riverside set a state record for lowest temperature at -53° F
Jan. 20-25, 1927	Entire State	Cold Weather	Harney Experiment Station reached -36° F
Feb. 1933	All of Oregon	Cold Weather	Coldest February to date for eastern Oregon. Seneca and Ukiah reached -54°F, all time records for Oregon.
Jan. 31 - Feb. 4, 1937	Statewide	Snowstorm	Heavy snows throughtout state.
mid Jan.- Feb., 1950	Across the State	Ice/Snowstor m Cold Weather	Extremely low temperatures for nearly two months; heaviest snowfalls since 1890; blizzard conditions from Jan. 9 to 18. Halted all traffic for three days and people were moved to safety by railway.
Mar. 1-2, 1960	Entire State	Snowstorm	Heavy snow throughout state. Four known injuries, but no fatalities. Major traffic jams.
Jan. 25-30, 1969	Entire State	Snowstorm	Heavy snow throughout state
Jan. 9-11, 1980	Entire State	Snowstorm	Series of string storms across state. Many injuries and power outages.
Feb. 7-8, 1985	Entire State	Snowstorm	Heavy snow throughout state
Feb. 1986	Central/Eastern Oregon	Snowstorm	Heavy snow. Traffic accidents; broken power lines
Mar. 23, 1988	Entire state	Snowstorm	Strong winds; heavy snow.
Feb. 1-8, 1989	Entire State	Snowstorm Cold Weather	Heavy snow and cold temperatures throughout state.
Feb. 11-16, 1990	Entire State	Snowstorm Strong Winds	Heavy snow throughout state
Jan. 6-7, 1991	All of eastern Oregon	Snowstorm	The higher lands of eastern Oregon accumulated between 1 and 6 inches of new snow. Two traffic related fatalities.
Nov. 1993	Cascade Mountains	Snowstorm	Heavy snow throughout region
Feb. 10, 1994	Southeastern Oregon	Snowstorm	Heavy snow throughout the region.
Jan. 16-18, 1996	Columbia Gorge, Willamette Valley	Ice/Snowstor m Cold Weather	Cold air funneling through the Columbia River Gorge with overrunning moisture created freezing rain with heavy accumulations of glaze ice. Scattered power outages and minor traffic accidents.
Feb. 2-4, 1996	Columbia Gorge, Willamette Valley	Ice Storm	A warm front overrunning cold air produced an ice storm that caused widespread disruptions of traffic and power outages. Numerous traffic accidents and one fatality.
Winter 1998-99	Entire State	Snowstorm	One of the snowiest winters in Oregon history (Snowfall at Crater Lake: 586 inches)
Jan. 10, 2000	Central Oregon	Heavy Snow	11 inches of new snow fell in La Pine at an elevation of 4,200 ft. This storm led to a fatality when icy roads caused a collision between a car and a logging truck on Highway 26 at the Ochoco Reservoir east of Prineville.
May 6, 2002	Central Oregon	Extreme Cold Wind Chill	Area low temperatures dipped into the mid teens and 20s across central and north central Oregon.
Oct. 30-31, 2002	Central Oregon	Extreme Cold Wind Chill	An arctic front moved through the region bringing much colder temperatures. Many locations broke all time records for the month of October. Madras saw a low of -2 degrees Fahrenheit.
Dec. 2003- Jan 2004	Most of Oregon	Snowstorm	Preliminary damage assessments from this event estimated almost \$16 million dollars in impacts to state and local agencies across most of Oregon
Nov. 2005	Jefferson County	Snowstorm Cold Weather	Snow fall and dropping temperatures halted road extension projects on J Street.

Table II-15 Significant Winter Storm History for Deschutes and Nearby Counties (cont.)

Date	Location	Event	Comments
Nov. 2006	Jefferson County	Snowstorm	Heavy snow caused sport cancellations.
Jan. 2008	Statewide	Snowstorm Cold Weather	Heavy snow and single digit weather.
Jan. 4-5, 2004	Central Oregon	Cold Wind Chill	An arctic air mass moved south out of British Columbia, setting daily record low temperatures for January 5th. Meacham broke an all time record low temperature on the morning of January 5th, with a low temperature of -31 degrees Fahrenheit. Madras saw a record low of -4. The cold temperatures and slick roadways resulted in several school closures and cancellations.
Apr. 17, 2006	Central Oregon	Heavy Snow	Heavy snow hit the south and east parts of Bend with 8 to 11 inches of snow.
Dec. 18-24, 2008	Central Oregon	Heavy Snow	Moist Pacific air over running Arctic air at the surface led to heavy snowfall.
Dec. 31, 2009	Central Oregon	Heavy Snow	A surge of moist Pacific air brought heavy snowfall. Camp Sherman saw 5 inches.
Jan. 24, 2010	Central Oregon	Heavy Snow	A moist Pacific disturbance brought heavy snowfall to northcentral and central Oregon. Snowfall amounts in inches include: Camp Sherman (7).
Apr. 2, 2010	Central Oregon	Heavy Snow	A strong cold front and associated upper level trough brought late season heavy snow.
Nov. 21-24, 2010	Central Oregon	Heavy Snow and Cold Temperatures	A powerful arctic front brought widespread heavy snow to much of Central Oregon. Snow totals ranged from 7 to 10+ inches in many areas including Bend and La Pine. Camp Sherman saw nearly a foot. In the wake of the heavy snow, bitter cold settled in with sub-zero low temperatures on Nov 24.
Dec. 17-18, 2010	Central Oregon	Heavy Snow	Abundant Pacific moisture combined with very cold temperatures to bring heavy snow to northern and central Oregon. Snow totals ranged from 6 to 10 inches with 8 inches near Redmond, just under 7 inches in Madras, and 9 inches at Camp Sherman.
Dec. 14-15, 2011	Central Oregon	Heavy Snow	A Pacific storm system and slow moving Arctic front brought a prolonged period of snow to the region. Snow totals of 6 to 10 inches were observed in many areas including Bend, Redmond, Tumalo, and Camp Sherman.
Jan. 17-18, 2012	Northern and Central Oregon	Heavy Snow	A series of storm systems interacted with an Arctic front to bring several waves of moderate to heavy snow to the region. Snow totals ranged from 8 to 15+ inches. Camp Sherman recorded 16 inches with totals ranging from 6 to 10 inches in many other areas including Bend, Black Butte Ranch, and La Pine.
Feb. 24-25, 2012	Central Oregon	Heavy Snow	A winter storm system brought a bout of heavy snow to some areas. 6 to 10 inches of snow fell from Sunriver to Camp Sherman.
Mar. 20-21, 2012	Central Oregon	Heavy Snow	A late season winter storm pummeled portions of Central Oregon. Snow totals ranged from 8 to 12 inches in many areas including Camp Sherman (12 inches), Culver (7.5 inches), and Black Butte Ranch (10 inches).
Feb. 6-8, 2014	Central Oregon	Heavy Snow	A series of storm systems brought several waves of moderate to heavy snow to the region with snow totals of 10 to 20+ inches. Select observations include Camp Sherman (22 inches), in and around Bend (16-18 inches), and Warm Springs (14 inches).
Nov. 12-14, 2014	Northern and Central Oregon	Ice and Heavy Snow	A warm frontal system and abundant moisture interacted with a shallow Arctic airmass, bringing a mixed mode of freezing rain and snow. Freezing rain eventually transitioned to heavy snow with hefty accumulations in many areas. Ice accumulations ranged from 0.5 to 1 inch, with nearly an inch observed in Bend. Snow totals include 20 inches near Redmond, 21 inches in Sisters, and 19 inches east of Prineville.

Table II-15 Significant Winter Storm History for Deschutes and Nearby Counties (cont.)

Date	Location	Event	Comments
Dec. 14-15, 2016	Entire State	Heavy Snow	A powerful Pacific storm system brought abundant moisture into the region. With cold air in place, many areas of northern and central Oregon saw moderate to heavy snow.
Jan. 3-4, 2017	Central Oregon	Heavy Snow	A strong winter storm system brought bouts of heavy snow to much of central and east-central Oregon.
Feb 7-9, 2017	Northern and Central Oregon	Heavy Snow, Sleet, and Freezing Rain	A slow moving winter storm brought widespread wintry precipitation to the Inland Northwest, including Oregon. Substantial snow accumulations occurred in many areas, including Central Oregon.
Nov. 10-11, 2017	Northern and Central Oregon	Heavy Snow	A strong upper storm system moved across southern Oregon, resulting in heavy snow banding across much of northern and central Oregon. This resulted in widespread heavy snow accumulations.
Mar. 1-2, 2018	Northern and Central Oregon	Heavy Snow	A late season winter storm brought snow to much of Oregon with moderate to heavy accumulations in Central and northern Oregon.
Feb. 3-4, 2019	Northern and Central Oregon	Heavy Snow	A series of winter storm systems brought hefty snow accumulations to the higher elevations of the Cascades and Blue Mountains and their adjacent slopes. This included moderate to heavy accumulations in and around Central Oregon.
Feb. 9-10, 2019	Northern and Central Oregon	Heavy Snow	A powerful Pacific storm collided with Arctic air to bring moderate to heavy snow to many areas. Snow totals of 6 to 12 inches were recorded in many areas of Central Oregon.
Feb. 23-25, 2019	Northern and Central Oregon	Heavy Snow	Southwesterly flow continued to bring moisture into an unseasonably frigid airmass east of the Cascades. This resulted in multi-day snow totals of 1 to 3 feet in some areas including Sisters (40 inches), Bend (33 inches), Redmond (30 inches), and Prineville (22 inches). The heavy snow resulted in at least a couple roof failures in the Bend area.
Nov. 26-27, 2019	Central Oregon	Heavy Snow	An early season winter storm brought snow totals of 6 to 10 inches to many areas of Central Oregon.
Feb. 12-16, 2021	Northern and Central Oregon	Heavy Snow	Several storm systems moved into the Inland Northwest in the wake of an unusually cold Arctic intrusion. This resulted in several rounds of moderate to heavy snows across much of northern, central, and eastern Oregon. Heavy snow fell in many areas with total accumulations up to 10 to 24 inches.

Sources: Oregon Weather Book, NOAA Storm Events Database, <http://www.ncdc.noaa.gov/stormevents/>, Accessed April 30, 2021.

In recent years, the challenge facing the region is the significant increase in population and growth in tourism as a local industry. Both of these shifts have generally brought new populations to the area, particularly with little or no experience with living and working in severe winter weather. This condition impacts shelter, access to medical services, transportation, utilities, fuel sources and telecommunication systems. In severe winter storm conditions, travelers must seek accommodations, sometimes in communities where lodging is limited or overextended. A significant amount of supplies including food and fuel are transported into the Deschutes Basin and in severe winter conditions, these necessities are often limited when road conditions are unfavorable. Likewise, unfavorable road conditions make emergency response operations more difficult for a more fragile population.

Recent shifts in climate patterns beginning in the 1960's have resulted in snowfall and cold weather shifts. While there have been record snowfalls, they are less frequent. The number of severe cold days has been fewer and less frequent. Fluctuating temperatures within storm events also creates the likelihood of ice dams, which can result in an increased flood threat as snows melt.

Hazard Identification

Winter storms occur in all parts of the county. The extent depends upon air temperatures, the level of moisture in the atmosphere, and elevation.

A severe winter storm is generally a prolonged event involving snow and cold temperatures. The characteristics of severe winter storms are determined by the amount and extent of snow, air temperature, and event duration. Severe storms have various impacts in different parts of the county. There may be a 20 degree temperature difference from Terrebonne in the north part of the county and La Pine in the south part of the county. The National Weather Service Pendleton office monitors the stations and provides public warnings on storm, snow and cold temperature events as appropriate.

Probability Assessment

The recurrence interval for significant winter storms throughout Oregon is about every 13 years; however, there can be many localized storms between these periods. Winter storms do occur in eastern Oregon regularly from November through February. Deschutes County experiences winter storms a couple times every year, to every other year.

Deschutes County's Natural Hazards Mitigation Steering Committee believes that the County's **probability of experiencing a winter storm event is "high"**, meaning one incident is likely within the next 10 – 35 year period. Based upon available information the Oregon NHMPs Regional Risk Assessment supports this probability rating for Deschutes County.⁵

Vulnerability Assessment

Perhaps the most advantageous aspect of Central Oregon's cold and snowy winters is the fact that the region is typically prepared, and those visiting the region usually come prepared. As can be expected, however, there are occasions when preparation cannot meet the challenge. In Deschutes County, extreme cold and heavy snow can disrupt farming practices. Likewise, schools have trouble heating their buildings. The constant freezing and melting of snow around manholes often lead to potholes, and power outages can be frequent in adverse weather. Finally, extreme cold can cause breaks in water pipelines when temperatures drop below 10 F. Specific estimates of property and infrastructural damages for winter storm events are not available at this time.

The Deschutes County Natural Hazards Steering Committee rated Deschutes County **as having a "high" vulnerability to winter storm hazards**; meaning that more than 10% of the region's population or assets would be affected by a major emergency or disaster. Based upon available information the Oregon NHMPs Regional Risk Assessment supports this vulnerability rating for Deschutes County.⁶

⁵ 2020 Oregon Natural Hazard Mitigation Plan. Department of Land Conservation and Development, 2020.

⁶ Ibid.

Risk Analysis

The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (1) the magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section), and (2) the likelihood or probability of the harm occurring. Table 2-6 of the Risk Assessment (Volume I) shows the county's Hazard Analysis Matrix which scores each hazard and provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard. Based on the matrix the **winter storm hazard is rated #1, out of 9 rated hazards, with a total score of 230.**

Community Hazard Issues

Life and Property

Severe winter storms contribute to threats on life and property. Injury and death are often associated with traffic accidents on snow and/or ice covered roads, physical exertion linked to shoveling snow and other activities involved in traveling through snow, and hypothermia from prolonged exposure to the cold. When streets and roads are affected by severe snow and ice, emergency vehicles including police, fire and medical may experience difficulty in reaching targeted destinations.

Roads

County, state, city and many private roads are routinely monitored for snow and ice. Jurisdictions and many private landowners in the rural-urban interface plow snow on a regular basis. Extreme snowfall and ice conditions usually place more demand on local jurisdictions, staff and budgets. Impassable roads hamper emergency response operations.

Power Lines

Extreme cold temperatures have caused power outages that interrupt services and damage property. Many outlying ranches and farms have generators and are generally self-sufficient in these events. However as the general population becomes more urban, fewer numbers of people have resources such as wood stoves, a traditional backup source for heat. Rising population growth and new infrastructure, particularly tourism related, create higher probability for damage to occur from severe winter storms as more life and property are exposed to risk.

Water Lines

The most frequent water system problems related to extreme cold weather are breaks in water mainlines. Breaks occur during severe cold events impacting residents and business. Inadequate insulated potable water and fire sprinkler pipes can rupture and cause extensive damage to property. Aligned with the extreme population growth, Deschutes County has a significant number of new residential and commercial structures which have been built under current codes that recognize severe cold weather conditions.

Creek flooding within a single storm event, or between events and fluctuating temperatures may lead to the buildup of ice dams in creeks. In the winter of 2003, an ice dam release on Whychus Creek caused ice and debris to build up and recede on the creek as it passed through Sisters. This release caused the creek level to rise to its high water mark, but broke loose before flooding homes.

More information on this hazard can be found in the Regional Risk Assessment for Region 6 of the Oregon NHMP.

Existing Authorities, Policies, Programs, and Resources

Existing authorities, policies, programs, and resources include current mitigation programs and activities that are being implemented by city, county, regional, state or federal agencies and/or organizations.

County and Cities

County and municipal Public Works and Road Departments have plans in place to mitigate and respond to severe winter storms. The plans are updated annually and routinely implemented. Utility companies have existing restoration plans that include routine upgrade and repair, emergency restoration, and public education. Additionally, schools and employers of large scale businesses and agencies have “snow-day” plans. These schedules routinely plan a minimum of five to eight “snow-days” per year.

State

Studded tires can be used in Oregon from November 1 to April 1. They are defined under Oregon Law as a type of traction tire. Research shows that studded tires are more effective than all-weather tires on icy roads, but can be less effective in most other conditions.

Highway maintenance operations are guided by local level of service (LOS) requirements. In general, classifications of highways receive more attention. Routes on the National Highway System network, primary interstate expressways and primary roads, will be cleared more quickly and completely. In Deschutes County, this includes Highway 97 and Highway 26. Critical areas like mountain passes will have snow-chain requirements for vehicles, and many local streets are “snow emergency routes” that will be cleared of parked cars. Parking lot and sidewalk snow removal is mostly the responsibility of property owners, sometimes by local ordinance.

Oregon Department of Transportation (ODOT) spends about \$16 million per year on snow and ice removal from the state highway system through winter maintenance practices. These practices include: snow plowing, sanding roadways for ice, and using anti-icing chemicals.

Through the educational collaboration between the Oregon Department of Forestry and the Pacific Northwest Chapter, International Society of Arboriculture (ISA) the *How to Recognize and Prevent Tree Hazards* activity brochure was created.

TripCheck provides traffic incident, weather, and highway condition reports, as well as useful links to bus, rail, airport, and truck information. The website provides road condition images from approximately 140 road cameras, including over 40 in rural areas such as mountain passes where knowing road conditions can be crucial to safety: <http://www.TripCheck.com/>.

Federal

The National Weather Service issues winter storm watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. The watches and warnings are broadcast over NOAA weather radio and are forwarded to the local media for retransmission using the Emergency Alert System. They also work closely with county and local officials to identify mitigation and risk management strategies, and provide briefings and support leading up to and during such events.

Hazard Mitigation Action Items

There are three identified winter storm action items for Deschutes County; in addition, several of the multi-hazard action items affect the winter storm hazard. An action item matrix is provided within Volume I, Section 3, while action item forms are provided within Volume IV, Appendix A. To view city actions see the appropriate city addendum within Volume III.

VOLUME III: JURISDICTIONAL AGENDA

Introduction

This document serves as the City of Bend's Addendum to the Deschutes County Natural Hazard Mitigation Plan (NHMP). The City's Addendum is considered part of the county's multi-jurisdictional plan, and meets the following requirements: (1) Multi-jurisdictional Plan Adoption §201.6(c)(5), (2) Multi-jurisdictional Participation §201.6(a)(3), (3) Multi-Jurisdictional Risk Assessment §201.6(c)(2) (iii), and (4) Multi-jurisdictional Mitigation Strategy §201.6(c)(3) (iv).

A description of the city specific planning and adoption process follows, along with detailed community specific action items; for detailed information see Volume IV, Appendix B. Information about the city's risk relative to the county's risk to natural hazards is documented in this addendum's Hazard Analysis and Issue Identification section. The section considers how the city's risk differs from or matches that of the county's; additional information on Risk Assessment is provided within Volume I, Section 2 of this NHMP.

How was the Plan Developed?

The NHMP was developed by the Deschutes County Natural Hazard Mitigation Plan steering committee, while this addendum was created by the City of Bend steering committee. The Deschutes County Emergency Manager was designated as the NHMP's convener and will take the lead in implementing, maintaining and updating the plan. Locally, the City of Bend Senior Planner convened a local steering committee for the purpose of developing the city's addendum.

The local steering committee was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. The local steering committee met once formally on April 28th, 2021 (see Appendix B for more information). Steering committee members contributed data and maps, reviewed and provided guidance towards the community profile, risk assessment, mitigation strategy (action items), and implementation and maintenance plan. The addendum reflects effort from the formal meeting and during subsequent informal meetings and communications between members of the steering committee and with Central Oregon Intergovernmental Council (COIC).

An open public involvement process is essential to the development of an effective plan. In order to develop a comprehensive approach to reducing the effects of natural disasters, the planning process should include opportunities for the public, neighboring communities, local and regional agencies, as well as private and nonprofit entities to comment on the plan.¹ COIC provided a publicly accessible project webpage for the general public in order to make meeting materials and contact information available throughout the update process.

¹ Code of Federal Regulations, Chapter 44. Section 201.6, subsection (b). 2015

In addition, COIC administered a public opinion survey to obtain additional input from the public regarding the county’s risks, vulnerabilities, hazards history, and mitigation strategies. See Volume IV, Appendix F for more information.

Updating the mitigation plan is a requirement to gain eligibility for the Federal Emergency Management Agency’s Pre-Disaster Mitigation, Hazard Mitigation, and Flood Mitigation Assistance grant programs. This project is funded through the Federal Emergency Management Agency’s (FEMA) FY20 Pre-Disaster Mitigation Competitive Grant Program (PDMC – PL-10-OR-2012-002).

The Bend Addendum to the Deschutes County NHMP was adopted on November 3, 2021 and approved by FEMA on October 28, 2021. The Deschutes MNHMP was approved by FEMA on October 28, 2021, the plan is effective for Deschutes County and Bend through October 27, 2026.

For more information on the composition of the steering committee and the process see this NHMP’s Volume I, Acknowledgements and Executive Summary, and Volume IV, Appendix B.

Action Item Matrix

The City’s action items were first developed through a two-stage process during the 2015 by the local steering committee, facilitated by Oregon Partnership for Disaster Resilience (OPDR). In 2021, the local steering committee, facilitated by Central Oregon Intergovernmental Council, updated the status of existing action items and added one new action item. In addition, there are 25 County Action Items that include Bend as an “Affected Jurisdiction.” For additional information see the discussion near the end of this document.

The City’s actions are listed below in matrix format. For more detailed information on each action, see the action forms within Attachment 1 of this addendum.

Table BA-I City of Bend Action Items

2021 Action Item	High Priority	Mitigation Action Title	Lead Agency	Partner Organization(s)	Timeline	Status
Multihazard #1		Identify, improve, and sustain collaborative programs focusing on the real estate and insurance industries, public and private sector organizations, and individuals.	Community Development	<u>Internal:</u> Police Department, Fire Department <u>External:</u> Deschutes County Emergency Services, RFPD #2	Long-Term	Ongoing
MH #2		Develop public and private partnerships to foster natural hazard program coordination and collaboration.	Community Development	<u>Internal:</u> Police Department, Bend Fire Department <u>External:</u> Deschutes County Emergency Services, RFPD #2	Short-Term	Ongoing
MH #3	X	Develop inventories of at-risk buildings and infrastructure, and prioritize mitigation projects based on those providing the most benefit (at the least cost) to the population of the City of Bend.	Community Development	<u>Internal:</u> Public Works, Engineering and Infrastructure, Bend Airport <u>External:</u> Deschutes County Emergency Services; OEM, DOGAMI, FEMA, IFA	Long-Term	Deferred
MH #4	X	Strengthen emergency services by maintaining the City of Bend Emergency Operations Plan, linking emergency services with hazard mitigation programs, and enhancing public education.	Bend Fire	<u>Internal:</u> Police, Fire, Public Works, City Administration <u>External:</u> Deschutes County Emergency Services; Bend Park and Recreation District	Ongoing	Ongoing
MH #5		Use technical knowledge of natural ecosystems and events to link natural resource management and land use organizations to mitigation activities and technical assistance.	Community Development	<u>Internal:</u> - <u>External:</u> Deschutes County Emergency Services, Forester; DOGAMI, WRD, ODF	Long-Term	Deferred
MH #6		Develop benchmarks for a disaster-resistant and resilient community.	Community Development	<u>Internal:</u> Police Department, Fire Department <u>External:</u> Deschutes County Emergency Services, Community Development	Short-Term	Deferred
MH #7		Develop and implement, or enhance, strategies for debris management for natural hazard (winter storm, wind, flood, etc.) events.	Public Works	<u>Internal:</u> Police, Fire, Public Works Departments <u>External:</u> Deschutes County Emergency Services, RFPD #2, Road Department; ODOT	Short-Term	Ongoing
Earthquake #1		Seismically retrofit vulnerable facilities and infrastructure to increase their resiliency to seismic hazards. Consider both structural and non-structural retrofit options.	Public Works/Utilities	<u>Internal:</u> Community Development, Engineering and Infrastructure Planning, Public Works <u>External:</u> Deschutes County Community Development; Bend Metro Park and Recreation District, Bend – LaPine Schools, Deschutes County Library	Long-Term	Ongoing
EQ #2		Improve local capabilities to perform earthquake building safety evaluations and to record and manage building inventory data.	Community Development	<u>Internal:</u> Community Development, Engineering and Infrastructure Planning <u>External:</u> Deschutes County Community Development, Emergency Services	Long-Term	Deferred
Flood #1		Identify critical public infrastructure and facilities located in flood hazard areas and implement mitigation and preparedness measures for those facilities.	Public Works/Utilities	<u>Internal:</u> Public Works, Engineering and Infrastructure Planning <u>External:</u> Deschutes County Community Development, Emergency Services, Road Department; ODOT	Long-Term	Ongoing
FL #2		Identify floodway obstructions and implement mitigation measures to remove obstructions.	Community Development	<u>Internal:</u> Engineering and Infrastructure Planning <u>External:</u> Deschutes County Community Development, Emergency Services, Roads; DSL, ODFW	Long-Term	Deferred

Source: City of Bend NHMP Steering Committee, 2021

Table BA-I City of Bend Action Items (continued)

2021 Action Item	High Priority	Mitigation Action Title	Champion	Partner Organization(s)	Timeline	Status
FL #3		Develop strategies to enhance the use of open space within the floodplain for flood mitigation, fish habitat, and water quality issues.	Community Development	<u>Internal:</u> Engineering and Infrastructure Planning, Community Development <u>External:</u> Deschutes County Community Development; Bend Park and Recreation District; DSL, ODFW, DLCD	Long-Term	Deferred
Volcano #1		Identify critical facilities and industries that may be affected by ash fall and develop and implement ash fall emergency response and mitigation projects.	Community Development	<u>Internal:</u> Engineering and Infrastructure Planning, Utilities, Streets <u>External:</u> Deschutes County Community Development, Emergency Services	Long-Term	Ongoing
VE #2		Collaborate with the USGS's Cascade Volcano Observatory and related agencies to create ash fall warning messages that are more appropriate for Bend.	Community Development / Communications	<u>Internal:</u> Communications, Police, Fire <u>External:</u> Deschutes County Emergency Services, Communications, 911; USGS, OSU-Cascades, OEM	Long-Term	Deferred
Wildfire #1		Inventory alternative firefighting water sources and encourage the development of additional sources.	Bend Fire	<u>Internal:</u> Fire Department, Engineering and Infrastructure Planning <u>External:</u> Deschutes County Forester, Emergency Services, 911; Project Wildfire,	Short-Term	Complete
WF #2	X	Encourage creation and adoption of wildland-urban interface maps to direct development requirements that assist wildfire mitigation.	Bend Fire	<u>Internal:</u> Fire Department, Community Development, Information Technology (GIS) <u>External:</u> Deschutes County Forester, Community Development, Emergency Services, 911; Project Wildfire	Short-Term	Deferred
WF #3		Increase communication, coordination, and collaboration between wildland-urban interface property owners, city and county planners, and fire prevention crews and officials to address inherent risks in wildland-urban interface areas, available prevention/ protection measures, and federal mitigation assistance programs.	Community Development	<u>Internal:</u> Community Development; Fire Department <u>External:</u> Deschutes County Forester, Community Development; RFPD #2, Emergency Services; Project Wildfire	Short-Term	Ongoing
WF #4		Implement fire mitigation activities in a manner consistent with the goals of promoting sustainable ecological management and community stability.	Code Enforcement	<u>Internal:</u> Community Development, Engineering and Infrastructure Planning <u>External:</u> Deschutes County Forester, Community Development; Project Wildfire; DLCD, ODFW; USFS, BLM	Short-Term	Ongoing
WF#5	X	Wildfire mitigation for critical water and sewer infrastructure.	Utilities / Community Development	<u>Internal:</u> Engineering, Bend Fire <u>External:</u> County Planning, Deschutes County Forester, Deschutes County Emergency Services, ODF, USFS, OEM, DLCD	Medium-Term	NEW

Source: City of Bend NHMP Steering Committee, 2021

How Will the Plan be Implemented?

The City Council will be responsible for adopting the City of Bend addendum to the Deschutes County NHMP. This addendum designates a coordinating body and a convener to oversee the development and implementation of action items. Because the city addendum is considered part of the county plan, the city will look for opportunities to partner with the County to maintain the plan, and coordinate mitigation efforts through the implementation of action items, etc. The City’s steering committee will convene after re-adoption of the City of Bend addendum annually with the county every spring. For more details on the meeting schedule and process, see Volume I, Section 4 of the county plan. The City’s Senior Planner will serve as the convener and will be responsible for convening the local steering committee. The convener will also remain active in the County’s planning process. The steering committee will seek to involve senior staff and decision makers throughout the duration of the five-year implementation and maintenance of the NHMP addendum.

Implementation through Existing Programs

Many of the Natural Hazards Mitigation Plan’s recommendations are consistent with the goals and objectives of the city’s existing plans and policies. Where possible, the City of Bend will implement the NHMP’s recommended actions through existing plans and policies. Plans and policies already in existence have support from local residents, businesses, and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, allowing them to adapt to changing conditions and needs. Implementing the NHMP’s action items through such plans and policies increases their likelihood of being supported and implemented.

The City of Bend currently has the following plans that relate to natural hazard mitigation:

Table BA-2 Existing Plans

Jurisdiction	Document	Year
City of Bend	Comprehensive Plan	2016
City of Bend	Bend Development Code 2.7.640 (Flood Plain Combing Zone)	2014
City of Bend	Emergency Operations Plan	2016
City of Bend	Transportation System Plan	2020
City of Bend	Greater Bend CWPP**	2016
City of Bend	Water Public Facility Plan**	2013
City of Bend	Sewer Public Facility Plan	2018
City of Bend	Stormwater Public Facility Plan	2014

***Update forthcoming in 2021*

Source: City of Bend

The steering committee and the community’s leadership have the option to add or implement action items at any time. This allows the steering committee to consider mitigation strategies as new opportunities arise, such as funding for action items that may not be of the highest priority. When new actions are identified, they should be documented

using an action item form (see Attachment 2). Once a proposed action form has been submitted to the convener, the action will become part of the City's addendum.

Continued Public Participation

Keeping the public informed of the city's efforts to reduce the city's risk to future natural hazards events is important for successful plan implementation and maintenance. The city is committed to involving the public in the plan review and updated process. The City Addendum along with the County Plan will be posted on-line on the Central Oregon Intergovernmental Council website, the County website, and the City of Bend Website so that the public may view the plan at any time.

In addition, natural hazards information dissemination is conducted throughout the year when opportunities present themselves via the city offices and website.

Plan Maintenance

The Deschutes County Natural Hazards Mitigation Plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the county plan update process, the city will also review and update its addendum. The convener will be responsible for convening the steering committee to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help the steering committee determine what components of the mitigation plan need updating. The steering committee will be responsible for updating any deficiencies found in the plan.

The remainder of this addendum includes three sections:

1. Community Profile and Asset Identification,
2. Hazard Identification and Risk Assessment, and
3. Mitigation Strategy section.

COMMUNITY PROFILE

ASSET IDENTIFICATION

This section provides city-specific asset identification. For information on the characteristics of Bend, in terms of geography, environment, population, demographics, employment and economics, as well as housing and transportation see Volume IV, Appendix C, *Community Profile*. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city-specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

We live in a place with a varied geography and communities. We would like to recognize and acknowledge the indigenous land of the Confederated Tribes of Warm Springs, Molalla, Paiute, Klamath, Modok, Yahooskin Band of Snake Indians, and Tribes of Middle Oregon. We want to recognize the people that came before us and honor their traditions and stewardship of the land. Acknowledgement is a simple, powerful way of showing respect for Indigenous People's history and culture.

Asset Identification

The following assets were identified by the steering committee in 2021:

Critical and Essential Facilities

- City Hall – 710 NW Wall Street, Bend, OR 97701
- Public Works:
 - Transportation – 1375 NE Forbes Road, Bend OR 97701
 - Utilities Business Office – 62975 Boyd Acres Road, Bend, OR 97701
 - Water Reclamation Facility – McGrath Road in unincorporated Deschutes County
 - Bridge Creek water intake facility – Skyline Road (unincorporated Deschutes County)
- Police Department and Municipal Court – 555 NE 15th Street
- Fire Department – offices and fire stations in Bend:
 - Administration – 1212 SW Simpson Ave, Bend, OR 97702
 - Station 301 – 1212 SW Simpson Ave, Bend, OR 97702
 - Station 302 - 19850 4th St, Bend, OR. 97701
 - Station 303 – 61080 Country Club Dr, Bend, OR 97702
 - Station 305 – 63377 SW Jamison Street, Bend, OR 97701
 - Station 306 – 425 NE 15th St, Bend, OR 97701
- Bend Municipal Airport – 63136 Powell Butte Road, Bend, OR 97701

Deschutes County Critical and Essential Facilities (Bend):

- Administration – 1300 NW Wall St
- Deschutes County Sheriff's Office Work Center and, Adult Community Justice – 63360 NW Britta St, Building 2
- Deschutes County Sheriff's Office Search and Rescue, and Emergency Services - 63360 NW Britta St. Building 3
- Deschutes County Sheriff's Office Automotive Unit - 63360 NW Britta Building 4
- 9-1-1 Services – 20355 Poe Sholes Drive
- Adult Corrections (Jail) 63333 Highway 20
- Community Development – 117 NW Lafayette Ave
- County Annex, Health Dept. – 1128 NW Harriman St
- Juvenile Community Justice Center – 63360 NW Britta St, Building 1
- County Courthouse Building (District Attorney) – 1164 NW Bond Street
- Deschutes County Sheriff's Office Complex – 63333 Highway 20
- Health Services Building – 2577 NE Courtney Drive
- Justice Building – 1100 NW Bond Street
- KIDS Center (Health Services) 1375 NW Kingston
- Mike Maier Building (Children and Families Commission) – 1130 NW Harriman St
- Property & Facilities/Information Technology Building – 14 NW Kearney Ave
- Recovery Center - 20370 Poe Sholes
- Road Department – 61150 SE 27th Street
- Rosie Bareis Community Campus – 1010 NW 14th St
- School Based Health Center – 2150 NE Daggett Lane
- Stabilization Center - 633111 NE Jamison St.
- Williamson Building (Health Services) - 1550 NE Williamson Blvd.
- Wall St Services Building (Health Services) – 1340 NW Wall Street

Critical Infrastructure

- Pacific Power – electric power utility
- Cascade Natural Gas – natural gas utility – 64500 OB Riley Road
- Bend Broadband (cable, landline phone, internet provider) – 63090 Sherman Road
- CenturyLink (cable, landline phone, internet provider) – 19550 Amber Meadow Dr. Suite 130136

Bend-La Pine School District (schools located in Bend)

- Elementary Schools:
 - Amity Creek – 437 NW Wall Street
 - Bear Creek – 51 SE 13th St
 - Elk Meadow – 60800 Brookwood Boulevard
 - Ensworth - 2150 NE Daggett Lane
 - High Lakes – 2500 NW High Lakes Loop
 - Highland Magnet – 701 NW Newport Avenue
 - Juniper Elementary – 1300 NE Norton Avenue
 - Lava Ridge - 20805 Cooley Road
 - North Star - 63567 NW Brownrigg Lane

- Pine Ridge – 19840 Hollygrape St
- RE Jewell Elementary – 20550 Murphy Rd
- Silver Rail - 61530 SE Stone Creek Lane
- Westside Village Magnet – 1101 NW 12th St
- William E. Miller – 300 NW Crosby Drive
- Middle Schools in Bend:
 - Cascade – 19619 Mountaineer Way
 - High Desert - 61000 Diamondback Lane
 - Pacific Crest - 3030 NW Elmwood Lane
 - Pilot Butte – 1501 NE Neff Road
 - REALMS (Rimrock Expeditionary Learning) – 63175 OB Riley Road
 - Sky View – 63555 NE 18th St
- High Schools in Bend:
 - Bend – 230 NE 6th St
 - Bend Technical Academy– 1291 NE 5th St
 - Caldera High School - SE 15th Street/Knott Rd
 - Mountain View – 2755 NE 27th St
 - REALMS (Rimrock Expeditionary Learning) - 20370 Brinson Blvd
 - Skyline - 20730 Brinson Blvd
 - Summit – 2855 NE Clearwater Drive

Colleges and Universities

- Central Oregon Community College – 2600 NW College Way
- Oregon State University, Cascades Campus:
 - Graduate & Research Center – 650 SW Columbia St
 - Main Campus - 1500 SW Chandler Way

Social Service Providers

Included below is a list of social service providers. For additional service providers, visit <https://centraloregonresources.org/full-directory> or contact Deschutes County Sheriff's Office Emergency Management.

- Deschutes County Health Services – 2577 NE Courtney Drive, Bend, OR
- Neighbor Impact – 20310 Empire Ave, #A100, Bend, OR 97701
- Housing Works
- American Red Cross, Mountain River Chapter – 815 SW Bond, Suite 110, Bend, OR 97702
- Salvation Army, Deschutes County – 515 NE Dekalb Ave, Bend, OR 97701
- St. Vincent De Paul – 950 SE 3rd, Bend, OR 97701
- Or Department of Human Services – Self Sufficiency Program – 1300 NW Wall St, Suite 101, Bend, OR 97701
- State of Oregon – Seniors and People with Disabilities – 1300 NW Wall Street, Suite 102, Bend, OR 97702
- Emergency shelters:
 - Bethlehem Inn – 3705 N. Highway 97, Bend, OR 97701
 - Cascade Youth and Family Center – 19 SW Century Drive, Bend, OR 97702

- Saving Grace – 1425 NW Kingston Ave, Bend, OR 97701
- Two shelters that are confidential and provide shelter for homeless, pregnant, and/or parenting teens
- The Shepherd’s House
- Child programs:
 - Boys and Girls Club of Central Oregon – 500 NW Wall Street, Bend, OR 97701
 - Alyce Hatch Center – 1406 NW Juniper, Bend, OR 97701
 - Cascade Youth and Family Center – 19 SW Century Drive, Bend, OR 97702
 - Central Oregon Family Resource Center – 1130 NW Harriman St, Suite B, Bend, OR 97701

Population

Bend’s estimated population as of July 1, 2020 is 92,840 people. The city’s population has grown an estimated 16,201 people or 21.3% since the 2010 Census.² The Population Research Center (PRC) at Portland State University has prepared population forecasts for Bend’s UGB from 2018 to 2068. The PRC projects Bend’s population will reach 109,338 by 2025 and 153,696 by 2040.

Bend’s population growth has occurred in all parts of the city, with more occurring on Bend’s west side and in southwest Bend. The groups that have seen the largest increases in household growth include Latino and Hispanic households and households composed of members 65 years and older.

Land Use

The City of Bend’s acknowledged comprehensive plan is the Bend Area General Plan. The Oregon Land Conservation and Development Commission first acknowledged the plan in 1981. The City last completed a major update of the plan in 1998. Since that time, the City has updated the plan chapters on demographics and population (2004); economic development (2005); transportation (2013), and public facilities and services (2013-2014). The City implements the plan through the Bend Development Code, which was adopted in 2006.

In September of 2016, the City of Bend and Deschutes County approved a 2,380 acre expansion of Bend’s urban growth boundary (UGB). In addition to the UGB expansion, the City Council approved a number of updates to the Bend Comprehensive Plan. The Council adopted a new Transportation System Plan (TSP) in 2020, and expects to adopt an Integrated Water System Master Plan in 2021, followed by updated Collection System and Stormwater Master Plans by 2023.

² Portland State University, Population Research Center, "Annual Population Estimates", 2020.

Bend Park and Recreation District

The Bend Park and Recreation District operates and maintains 82 parks and open spaces, and 88 miles of trail.³ The district has its own tax district and is governed by a five-member elected board of directors that is managed by an Executive Director. The district's parks include 36 neighborhood parks (155 acres), 24 community parks (543 acres), 3 regional parks (954 acres), and 18 natural areas (906 acres) and more than 24 facility buildings.⁴

Tourist Locations

This list includes the top tourist locations of interest in the event of a natural hazard, but is not comprehensive. For more information on tourism locations in Bend, go to

<https://www.visitbend.com/>

- Drake Park – adjacent to flood plain
- Pilot Butte – Highway 20
- Shevlin Park
- Pine Nursery Park
- Farewell Bend Park adjacent to Old Mill District
- Several public golf courses:
 - River's Edge
 - Awbrey Glen
 - Bend Golf and Country Club
- Old Mill District (shopping & entertainment) 450 SW Powerhouse Drive #2
- Deschutes River
- The Pavilion

Economy

Bend is the largest city east of the Cascade Mountains, and the seventh largest in Oregon. As such, it serves as a large regional hub for retail sales, health care, higher education, and leisure, hospitality, and tourism. The growing traded sector industries in Bend include:

- Bioscience;
- Health and Hospital Care;
- Aviation and Aerospace;
- Outdoor Recreation Equipment and Apparel;
- Software;
- Specialty Manufacturing;
- Corporate and Administrative Offices, and;
- Brewing and Distilling.

³ Bend Park and Recreation District website, <http://www.bendparksandrec.org>, accessed April 14, 2021.

⁴ Bend Park and Recreation District, "Parks, Recreation, and Green Spaces Comprehensive Plan", February 2012 update.

The seasonally adjusted unemployment rate for Deschutes County (in which Bend is the largest city and county seat) was 8.6% for 2020.

Cultural and Historic Resources

The sites (Table BA-3) and structures (Table BA-4) listed below represent the city’s official list of historic places compiled by the city and county, and approved by the Oregon Land Conservation and Development Commission.

Table BA-3 Historic Sites

Sites Designated with Plaques	Location
A.M. Drake Homesite	Drake Park
Foley Landmark	Pilot Butte State Park
1813 Rock	129 NW Idaho Street
Bend School Landmark	Drake Park
Central Oregon Pioneers' Landmark	Pioneer Park
Johns Landmark	Drake Park
Oregon Trunk Freight Warehouse Site	Railroad tracks & NW Division
Pilot Butte Inn Site	1133 NW Wall Street
Shevlin-Hixon Mill site	Shevlin Center near dam
Weist Homesite Landmark	1315 NE Third Street
Brooks Scanlon Craneshed building	721 SW Industrial Way

Source: City of Bend

Table BA-4 Historic Structures

Historic Structure	Location
A. J. Tucker Blacksmith Shop	200-202 NW Greenwood Avenue
Bend Athletic Club Gymnasium	520 NW Wall Street Bend
August Nelson Building	838 NW Bond Street
Charles Boyd Homestead	20410 Bend River Mall Drive
Cozy Hotel	327 NW Greenwood Avenue
Delaware Grocery	845 NW Delaware Avenue
Deschutes County Library Building	507 NW Wall Street
Downing Hotel	1033 NW Bond Street
Evan A. Sather Home	7 NW Tumalo Avenue
First Presbyterian Church	157 NW Franklin Avenue A.L.
A. L. French Home	429 NW Georgia Avenue Hoover's
George Palmer Putnam House	606 NW Congress Street
H. E. Allen House	875 Brooks Street Bend
James E. Reed House	45 NW Greeley Avenue
John I. West Building	130 NW Greenwood Avenue
Kenwood School	701 NW Newport Avenue
Keyes House	912 NW Riverside Boulevard
Liberty Theatre	849-851 NW Wall Street
Lucas House	42 NW Hawthorne Avenue
Mountain View (Mayne) Hospital	515 NW Kansas Avenue
N.P. Smith Pioneer Hardware Building	935-937 NW Wall Street
Nels and Lillian Andersen House	63160 Nels Anderson Road
Niswonger House	44 NW Irving Avenue
O'Donnel Building	921-933 NW Wall Street
O'Kane Building	115 NW Oregon Avenue
Old Bend High School Building	520 NW Wall Street
Old Clinic	731 NW Franklin Avenue
Old U.S. Post Office	777 NW Wall Street
Pierson Blacksmith Shop	211 NW Greenwood Avenue
Bend Railroad Depot	1160 NE Division Street Bend
Reid School	129 NW Idaho Avenue

Source: City of Bend

Table BA-4 Historic Structures (continued)

Historic Structure	Location
Sawyer House	434 Drake Road
Shevlin-Hixon Executive House	545 NW Congress Street
Spheir Building	901 NW Bond Street
St. Francis Catholic Church	494 NW Lava Road
Stover House	1 Rocklyn Road
Thomas McCann House	440 NW Congress Street
Trinity Episcopal Church	469 NW Wall Street
Steidel and Tweet irrigation dam	Division St. near Yale Avenue
Hoover's Universal Garage	124-128 NW Greenwood Avenue Steidl
Bend Water & Light Co. Powerhouse/dam	Foot of Vermont Street Bend
Bend Woolen Mill	1854 NE Division Street
Wright Hotel	215 NW Greenwood Avenue

Source: City of Bend

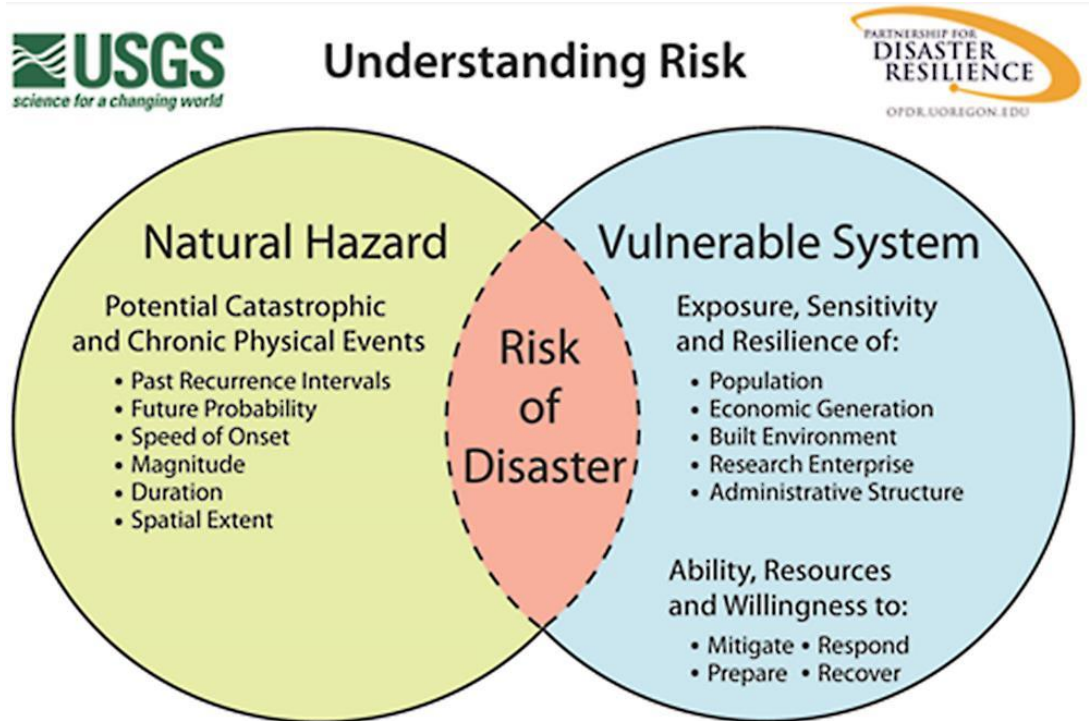
RISK ASSESSMENT

This section of the NHMP addendum addresses 44 CFR 201.6(b)(2) - Risk Assessment. In addition, this chapter can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – Areas Subject to Natural Hazards. Assessing natural hazard risk has three phases:

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

The information presented below, along with hazard specific information presented elsewhere in this addendum, within the Hazard Annexes (Volume II), and community characteristics presented in the Community Profile (Appendix C), will be used as the local level rationale for the risk reduction actions identified in this addendum. The risk assessment process is graphically depicted in Figure BA-1 below. Ultimately, the goal of hazard mitigation is to reduce the area where hazards overlap vulnerable systems.

Figure BA-1 Understanding Risk



Source: Oregon Partnership for Disaster Resilience

Hazard Analysis Methodology

This NHMP utilizes a hazard analysis methodology that was first developed by FEMA circa 1983, and gradually refined by the Oregon Military Department's Office 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%.

This 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 shown in the table below. See Volume I, Section (3 Risk Assessment) for more information.

Hazard Analysis

On February 11th, 2015, the City of Bend addendum steering committee developed their hazard vulnerability assessment (HVA), which was then updated on April 28th, 2021, using the County's HVA as a reference. Changes from the County's HVA were made where appropriate to reflect distinctions in vulnerability and risk from natural hazards unique to the City of Bend, which are discussed throughout this addendum.

Table BA-5 shows the HVA matrix for Bend showing each hazard listed in order of rank from high to low. For local governments, conducting the hazard analysis is a useful step in planning for hazard mitigation, response, and recovery. The method provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard.

Table BA-5 Hazard Analysis Matrix – City of Bend

Hazard	Maximum				Total Threat Score	Hazard Rank
	History	Vulnerability	Threat	Probability		
Wildfire	20	50	100	70	240	# 1
Winter Storm	20	50	90	70	230	# 2
Windstorm	20	25	80	70	195	# 3
Drought	20	15	70	70	175	#4
Volcano	2	50	100	21	173	#5
Earthquake (Cascadia)	2	40	100	7	149	#6
Flood	16	25	50	56	147	# 7
Earthquake (Crustal)	2	25	80	7	114	# 8
Landslide	2	15	20	7	44	# 9

Source: City of Bend NHMP Steering Committee, 2021

Three chronic hazards (wildfire, winter storm, and windstorm) and one catastrophic hazard (Cascadia earthquake) rank as the top four hazard threats to the city (Top Tier). The volcano, drought, and flood hazards comprise the next three highest ranked hazards (Middle Tier), while crustal earthquake and landslide hazards comprise the lowest ranked hazards (Bottom Tier).

Table BA-6 categorizes the probability and vulnerability scores from the hazard analysis for the city and compares the results to the assessment completed by the Deschutes County NHMP Steering Committee (areas of differences are noted with **bold** text within the city ratings).

Table BA-6 Probability and Vulnerability Comparison

Hazard	Bend		County	
	Probability	Vulnerability	Probability	Vulnerability
Drought	High	Low	High	Low
Earthquake (Cascadia)	Low	High	Low	High
Earthquake (Crustal)	Low	Moderate	Low	Moderate
Flood	High	Moderate	High	Low
Landslide	Low	Low	Low	Low
Volcano	Low	High	Low	High
Wildfire	High	High	High	High
Windstorm	High	Moderate	High	High
Winter Storm	High	High	High	High

Source: City of Bend NHMP Steering Committee and Deschutes County NHMP Steering Committee, 2021

Drought

A drought is a period of drier than normal conditions that results in water-related problems. 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.

The steering committee determined that the city's probability for drought is **high** (which is the same as the county's rating) and that their vulnerability to drought is **low** (which is the same as the county's rating).

The city has ample high quality surface and groundwater supplies fed primarily by the Bridge Creek watershed and from the Deschutes regional aquifer. Groundwater supplies are utilized as a supplemental water source when snowmelt or heavy precipitation increases the surface water turbidity. In addition, the City of Bend actively reclaims water and encourages water conservation through their WaterWise program.

For more information on the Drought Hazard (including history and extent) see the Drought Annex in Volume II.

Earthquake

Oregon and the Pacific Northwest in general are susceptible to earthquakes from four sources: 1) the off-shore Cascadia Fault Zone; 2) deep intra-plate events within the subducting Juan de Fuca Plate; 3) shallow crustal events within the North American Plate; and 4) earthquakes associated with volcanic activity.⁵

The areas most susceptible to ground amplification and liquefaction have young, soft alluvial sediments, found along river and stream channels. The extent of the damage to structures and injury and death to people will depend upon the type of earthquake, proximity to the epicenter and the magnitude and duration of the event.

The steering committee HVA evaluated both crustal earthquakes and a Cascadia earthquake. The steering committee determined that the city's probability of experiencing a crustal earthquake is **low** (which is the same as the county's rating) and that their vulnerability to a crustal earthquake is **moderate** (which is the same as the county's rating). The steering committee determined that the city's (and State's) probability of experiencing a Cascadia earthquake is **low** (which is the same as the county's rating) and that their vulnerability to a Cascadia earthquake is **high** (which is the same as the county's rating).

The concentration of residents, businesses, and infrastructure within the City of Bend is greater than anywhere else in the county. Additionally, much of the city's critical infrastructure is constructed of un-reinforced masonry (which is especially vulnerable to seismic events) and built prior to the current seismic safety standards of the 1990s. Although there are several faults located in the Bend vicinity (Table II-6), the city is not particularly susceptible to liquefaction, and is not expected to experience very strong to violent shaking in an earthquake event (see Tables II-5 and II-6). As such, the city's greatest vulnerability to earthquakes has more connection to the age of the city's infrastructure and buildings than to the particular geology of the area. The city considers itself to have high vulnerability to a Cascadia earthquake event due to secondary effects of the hazard,

⁵Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. 1999

including access to transportation routes, energy resources, communications, and the need to assist with refugees from the damage that is expected west of the Cascades.

As noted above the city has a high concentration of buildings built prior to 1990, which increases the city's vulnerability to the earthquake hazard. Information on specific buildings' estimated seismic resistance, determined by DOGAMI in 2007, is shown in Tables BA-6 to 8 below. The tables below display the rankings of all facilities within the city's jurisdiction; each "X" represents one building within that ranking category.

Table BA-7 shows evaluated school facilities. Of the school facilities evaluated by DOGAMI using RVS, two (2) have very high (100% chance) collapse potential, and 18 buildings have high (greater than 10% chance) collapse potential. It is important to note that the Rapid Visual Survey Scores have not been updated by DOGAMI since 2007. However, collapse potential for new buildings can be assumed low, given new building codes.

Table BA-7 Rapid Visual Survey Scores: Schools

Facility	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Elementary Schools				
Amity Creek Elem. School (437 NW Wall St, Bend)			XX	
Bear Creek Elementary School (51 SE 13th St, Bend)	XXX	XXX		
Buckingham Elementary School (62560 Hamby Rd, Bend)			X	
Elk Meadow Elementary School (60880 Brookwood Blvd, Bend)			X	
Ensworth Elementary School (2150 NE Dagget Ln, Bend)	X			
High Lake Elementary School (2500 NW High Lakes Lp, Bend)	X			
Highland School at Kenwood Elem. School (701 NE Newport, Bend)			XX	
Juniper Elem. School (1300 NE Norton St, Bend)		XXXX	X	X
RE Jewell Elementary School (20550 Murphy, Bend) - Addition Admin Office (Aug. 2008) - Remodel Admin Office (Aug. 2008)			X	
Lava Ridge Elementary School (20805 Cooley Rd, Bend)	X			
Pine Ridge Elementary School (19840 Hollygrape St, Bend)	X			
Tumalo Elementary School (19835 2nd St, Bend)	X	X	XXXXX	
Westside Village Magnet School at Kingston Elementary School (1101 NW 12th St, Bend)	X			
Middle Schools				
Cascade Middle School (19619 Mountaineer Way, Bend) - Addition of Gymnasium, Admin office (Aug. 2008) - Remodel Admin Offices, bathrooms (Aug. 2008)			XX	
High Desert Middle School (61111 27th St, Bend)			X	
Pilot Butte Middle School (1501 NE Neff, Bend)	XX	XXX		X
Sky View Middle School (63555 NE 18th St, Bend)	X			

Source: DOGAMI 2007. Open File Report 0-07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.

Table BA-7 Rapid Visual Survey Scores: Schools (continued)

Facility	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
High Schools				
Bend Senior High School (230 NE 6th St, Bend)	X	XXXXXXX	X	
Marshall High School (1291 NE 5th St, Bend)		XX		
Mountain View Senior High School (2755 NE 27th St, Bend) - Addition Classroom (435 sf) (Aug. 2008) - Remodel Classroom (898 sf) (Aug. 2008)	XX	XXXX	X	
Summit High School (2855 NW Clearwater Dr, Bend)	X			

Source: DOGAMI 2007. Open File Report 0-07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.

Table BA-8 shows evaluated community college facilities. Of the buildings evaluated by DOGAMI using RVS, none have very high (100% chance) collapse potential, and nine (9) buildings have high (greater than 10% chance) collapse potential. It is important to note that the Rapid Visual Survey Scores have not been updated by DOGAMI since 2007. However, collapse potential for new buildings can be assumed low, given new building codes.

Table BA-8 Rapid Visual Survey Scores: Community College

Facility	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Central Oregon Community College - Bend Campus				
Bookstore	X			
Boyle Education Center			X	
Cascade Hall	X			
Grandview Student Union Center			X	
Juniper		X		
Library	X			
Mazama Gym			X	
Modoc (Old Library)			X	
Ochoco Hall			X	
Pence			X	
Pinckney Art Center			X	
Pioneer Hall			X	
Ponderosa			X	

Source: DOGAMI 2007. Open File Report 0-07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.

Table BA-9 shows evaluated public safety and hospital facilities. Of the buildings evaluated by DOGAMI using RVS all have low (< 1% chance) collapse potential. It is important to note that the Rapid Visual Survey Scores have not been updated by DOGAMI since 2007. However, collapse potential for new buildings can be assumed low, given new building codes.

Table BA-9 Rapid Visual Survey Scores: Public Safety and Hospital

Facility	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Public Safety				
Bend Police Department (555 NE 15th St, Bend)	X			
Bend FD - East Station 304 (62420 Hamby Rd, Bend)	X			
Bend FD - South Station 303 (61080 Country Club Rd, Bend)	X			
Bend FD - Tumalo Station 302 (19850 4th St, Bend)	X			
Bend FD - West Station 301 (1212 SE Simpson Ave, Bend)	X			
Deschutes County RFPD #2 (63377 Jamison St, Bend)	X			
Deschutes County Sheriff's Office/ EOC (63333 W Hwy 20, Bend)	X			
Hospitals				
St. Charles Medical Center - Bend (2500 NE Neff Rd, Bend)	XX			

Source: DOGAMI 2007. Open File Report 0-07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.

For more information on the Earthquake Hazard (including history and extent) see the Earthquake Annex in Volume II.

Flood

Flooding results when rain and snowmelt creates water flow that exceeds the carrying capacity of rivers, streams, channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall. Most of Oregon's destructive natural disasters have been floods.⁶ Flooding can be aggravated when rain is accompanied by snowmelt and frozen ground; the spring cycle of melting snow is the most common source of flood in the region. The principal types

⁶ Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. 1999

of flood that occur in Bend include: spring/snowmelt flooding, warm winter rain-on-snow flooding, Ice jams, flash floods, and dam failure.

The steering committee determined that the city’s probability for flood is **high** (which is the same as the county’s rating) and that their vulnerability to flood is **moderate** (which is higher than the county’s rating).

The city’s high ratings are due to the fact that Bend is bisected by the Deschutes River which is susceptible to various winter and spring flood events including ice jamming. Ice jams on the Deschutes and Little Deschutes rivers have created flood conditions in the past and will continue to do so due to local topography. Ice jams commonly happen during the winter and early spring, while the river is still frozen. Sudden warming at higher altitudes can melt waters resulting in increased runoff of water and ice into large reaches of frozen river below. On the way downstream, the ice can “jam” in narrow places on the river or against a road crossing, effectively damming the river, sometimes followed by a sudden breach and release of the water and ice. In addition, the city is concerned that changes in the character of the river channel (sediment buildup) will affect river flooding if a large event occurs. Short duration flash floods also impact the community’s stormwater system, including the ability of pipes and ditches to convey short precipitation, causing damage and economic impacts. Action items are included to address the concerns with ice jamming and the changes to river character.

National Flood Insurance Program (NFIP)

The Deschutes County Flood Insurance Rate Maps (FIRMs) were modernized in 2007. The table below shows that as of April 2021, Bend has 60 National Flood Insurance Program (NFIP) policies in force and five (5) paid claims. The city’s last Community Assistance Visit (CAV) was July 20, 1994. The city is not a member of the Community Rating System (CRS). The table displays the number of policies by building type and shows that the majority of residential structures that have flood insurance policies are single-family homes (50) and that there is one (1) non-residential structure with flood insurance policies. Additionally, there is one property that is a minus rated A-zone property.

The community repetitive flood loss record for Bend does not include any repetitive flood loss, or severe repetitive flood loss, buildings and has not had any repetitive loss claims.

Table BA-10 Flood Insurance Detail

Jurisdiction	Current FIRM Date	Initial FIRM Date	Total Policies	Pre-FIRM Policies	Policies by Building Type				Minus Rated A Zone
					Single Family	2 to 4 Family	Other Residential	Non-Residential	
Bend	9/28/2007	9/4/1987	60	21	50	3	1	1	1
Jurisdiction	Insurance in Force	Total Paid Claims	Pre-FIRM Claims Paid	Substantial Damage Claims	Repetitive Loss Buildings	Severe Repetitive Loss		CRS Class Rating	Last CAV
						Buildings	Amount		
Bend	\$21,792,700	5	4	0	0	0	\$50,392	NP	7/20/1994
* Portion of entire county under county jurisdiction									
NP - Not Participating NA - Information not Available/ Not Applicable									

Source: Information compiled by Department of Land Conservation and Development, April 2021.

For more information on the Flood Hazard (including history and extent) see the Flood Annex in Volume II.

Landslide

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.

The steering committee determined that the city's probability for landslide is **low** (which is the same as the county's rating) and that their vulnerability to landslide is **low** (which is the same as the county's rating).

The city has had no problems with landslides in city limits in known history and is located in a generally stable area (the city is generally located on basalt with six-inches of topsoil). A few neighborhoods within the city (Awbrey Butte, etc.) are located on steep hillsides but have not experienced problems in the past.

For more information on the Landslide Hazard (including history and extent) see the Landslide Annex in Volume II.

Volcano

The Pacific Northwest lies within the "ring of fire," an area of consistent volcanic activity surrounding the Pacific Basin. Volcanic events occur regularly along the ring of fire, in part because of the movement of the Earth's tectonic plates. Volcanic events have the potential to coincide with numerous other hazards including ash fall, earthquakes, lava flows, pyroclastic flows, lahars, debris flows, and landslides.

The steering committee determined that the city's probability for volcanic event is **low** (which is the same as the county's rating) and that their vulnerability to volcanic event is **high** (which is the same as the county's rating).

Were a volcanic event to occur in the Cascades region of Oregon, Bend could be at risk for ash fall, depending on the severity of the event and the direction of the wind. Due to Bend's proximity to the Three Sisters and Newberry Crater, in relation to other areas within eastern Oregon, the effects of a volcanic event may be more disruptive to normal business, economic activity, and health.

For more information on the Volcano Hazard (including history and extent) see the Volcano Annex in Volume II.

Wildfire

Wildfires occur in most areas across the county, often these fires require a suppression response due to uncontrolled burning or threats to homes and infrastructure. Fire is an essential part of Deschutes Counties ecosystem, but can also pose a serious threat to life

and property particularly in growing rural communities. The point at which the wildland and urban growth intersect is the Wildland Urban Interface (WUI). Much of Deschutes County including Bend, is considered WUI. The increase in residential development in interface areas has resulted in greater wildfire risk. Fire has historically been a natural wildland element that has shaped the landscape and vegetation here in Central Oregon. With the expansion of homes into the wildland interface these homes are often threatened by wildfire. New residents in remote locations are often surprised to learn that in moving away from built-up urban areas, they have also left behind readily available fire services providing structural protection.

The steering committee determined that the city's probability for wildfire is **high** (which is the same as the county's rating) and that their vulnerability to wildfire is **high** (which is the same as the county's rating).

The city experiences the effects of wildfire frequently (example, Two Bulls Fire in 2014 and Awbrey Hall in 1990; see Wildfire Annex Figure II-19 for a map of the large wildfire history). The Greater Bend Area Community Wildfire Protection Plan (CWPP, August 2016, to be updated in 2021) relies upon (1) the Oregon Department of Forestry Assessment of Risk Factors and (2) the classification ratings of individual areas under the Oregon Forestland-Urban Interface Fire Protection Act of 1997 (Senate Bill 360) to determine fire risk within the Greater Bend Wildland-Urban Interface (WUI). According to the Senate Bill 360 ratings, Bend's East UGR and West UGR are rated as High fire risk, and according to the ODF Assessment all areas within the Greater Bend WUI are rated with a High probability of wildfire risk occurring and Extreme vulnerability (except for East UGR which is rated High).⁷ In addition to general concerns for the safety of residents and structures, the city's primary drinking water is sourced from the Bridge Creek watershed (west of the city) and is considered vulnerable to wildfire. Goals, objectives and accomplishments in reducing the risk from wildfire are included in the Greater Bend CWPP. This includes fuels treatments in the surrounding forest west of Bend and on rangelands to the East of Bend where fire is also an integral recurring part of the ecosystem. For more information on wildfire risk and fuels reduction projects see the Greater Bend Area CWPP and visit the Project Wildfire website: <http://www.projectwildfire.org/>.

For more information on the Wildfire Hazard (including history and extent) see the Wildfire Annex in Volume II and the Greater Bend CWPP.

Windstorm

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Although windstorms can affect the entirety of Deschutes 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.

⁷ The ODF Assessment considers the likelihood of a fire occurring, hazard rating, protection capability, human and economic values protected, structural vulnerability to determine the overall score. For detailed information review the CWPP available on the Project Wildfire website: <http://www.projectwildfire.org/>

The steering committee determined that the city's probability for windstorm is **high** (which is the same as the county's rating) and that their vulnerability to windstorm is **moderate** (which is the lower than the county's rating).

Historical wind events have uprooted trees, damaged roofs and windows, and damaged utility lines. Windstorms have not caused disastrous local damage but are a persistent problem. Windstorms are often associated with microbursts (thunderstorms). A primary windstorm vulnerability for the community is damage to utility lines, including fiber optics, which are key to the economic sectors of the community.

For more information on the Windstorm Hazard (including history and extent) see the Windstorm Annex in Volume II.

Winter Storm

Severe winter storms can consist of rain, freezing rain, ice, snow, cold temperatures, and wind. They originate from troughs of low pressure offshore that ride along the jet stream during fall, winter, and early spring months. Severe winter storms affecting Deschutes County typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from November through March.

The steering committee determined that the city's probability for winter storm is **high** (which is the same as the county's rating) and that their vulnerability to winter storm is **high** (which is the same as the county's rating).

Bend is located at a higher elevation east of the Cascades, which is a major contributor to winter storms. Major winter storms can and have occurred in the Bend area, and while they typically do not cause significant damage; they are frequent and have the potential to impact economic activity. Road closures on Highway 97, or the passes to the Willamette Valley (Highways 58 and 126), due to winter weather are a common occurrence and can interrupt commuter and large truck traffic. The city budgets funds for seasonal winter storm needs, such as clearing roads.

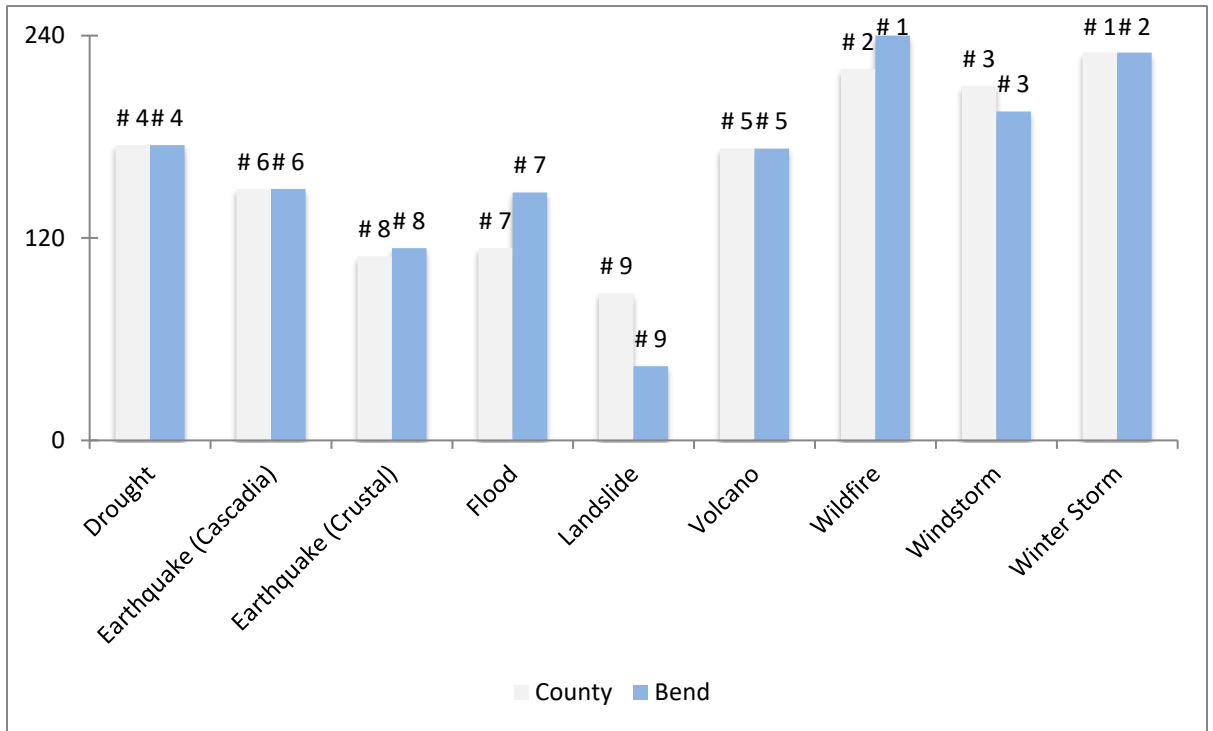
For more information on the Winter Storm Hazard (including history and extent) see the Winter Storm Annex in Volume II.

Summary

The figure below presents a summary of the hazard analysis for the City of Bend and compares the results to the assessment completed by the Deschutes County NHMP Steering Committee.

In terms of history, probability, vulnerability, and maximum threat, the city overall rated their threat to the wildfire hazard higher than the county. The top three hazards for the city and the county are wildfire, winter storm, and windstorm.

Figure BA-2 Overall Hazard Analysis Comparison – Bend and Deschutes County



Source: City of Bend NHMP Steering Committee and Deschutes County NHMP Steering Committee, 2021

Mitigation Plan Mission

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

The mission of the Deschutes County NHMP is:

To promote sound public policy designed to protect people, critical facilities, infrastructure, private property, and the environment from natural hazards.

This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the county towards building a safer, more disaster resistant community.

The Bend steering committee reviewed the 2021 NHMP plan mission statement and agreed it accurately describes the overall purpose and intent of this plan. The Steering Committee believes the concise nature of the mission statement allows for a comprehensive approach to mitigation planning.

Mitigation Plan Goals

Mitigation plan goals are more specific statements of direction that Deschutes 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.

The Bend Addendum steering committee reviewed and agreed to the 2021 Deschutes County NHMP plan goals. 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 to implement first, should funding become available. Below is a list of the 2021 NHMP goals:

Goal 1 - Protect life and reduce injuries resulting from natural hazards.

Goal 2 - Minimize property damage from natural hazards.

Goal 3 - Minimize damage to critical or essential infrastructure and services from natural hazards.

Goal 4 - Enhance the ability of Deschutes County's economy to rebound quickly from the effects of natural hazard events.

Goal 5 - Minimize project impacts to the environment and utilize natural solutions to protect people and property from natural hazards.

Goal 6 - Enhance the County's capability to implement a comprehensive County wide natural hazards mitigation strategy.

Goal 7 - Motivate the "whole community" to build resilience and mitigate against the effects of natural hazards through engagement, listening, learning, information-sharing, and funding opportunities.

Goal 8 - Eliminate development within mapped hazardous areas where the risks to people and property cannot be practicably mitigated.

Goal 9 - Minimize damage to historic and cultural resources from natural hazards.

Goal 10 - Enhance communication, collaboration, and coordination among agencies at all levels of government, sovereign tribal nations, and the private sector to mitigate natural hazards.

Goal 11 - Mitigate the inequitable impacts of natural hazards by prioritizing and directing resources and investments to build resilience in the most vulnerable populations and the communities least able to respond and recover.

Goal 12 - Develop, integrate, and align natural hazards mitigation and climate adaptation efforts based on the evolving understanding of the interrelationships between climate change and climate-related natural hazard events.

Goal 13 - Reduce repetitive and severe repetitive flood losses.

Goal 14 - Minimize or eliminate potential impacts from dams posing the greatest risk to people, property, and infrastructure.

(Note: although numbered the goals are not prioritized.)

Mitigation Plan Action Items

Short- and long-term action items identified through the planning process are an important part of the mitigation plan. Action items are detailed recommendations for activities that local departments, citizens and others could engage in to reduce risk. They address both multi-hazard (MH) and hazard-specific issues. Action items can be developed through a number of sources such as steering committee work sessions, stakeholder input, etc. A description of how the plan's mitigation actions were developed is provided below.

Action Item Worksheets

Each action item has a corresponding action item worksheet describing the activity, identifying the rationale for the project, identifying potential ideas for implementation, and assigning coordinating and partner organizations. The action item worksheets can assist the community in pre-packaging potential projects for grant funding. The worksheet components are described within Volume I, Section 3 (Mitigation Strategy). The City specific action item worksheets are located in Attachment 1, *Action Item Forms*.

The City is also a party to several actions described in the County NHMP; each jurisdiction listed on the County Action Item forms as an “Affected Jurisdiction” will contribute to and work towards completion of that action as it pertains to their jurisdiction. **There are 26 County Action Items that include Bend as an “Affected Jurisdiction.”** For detailed information on each County level action item form see Volume I, Section 3, *Mitigation Strategy* and Volume IV, Appendix A, *Action Item Forms*.

Action Item Development Process

Development of action items was a multi-step, iterative process that involved brainstorming, discussion, review, and revisions. Action items were developed by the steering committee and were influenced by actions first identified in the City of Bend Emergency Operations Plan (2009). A number of actions identified by the County steering committee include the City as an affected jurisdiction; these actions are broad actions that include implementation components at both the county and city level. All actions were reviewed by the committee and revised as necessary before becoming a part of this document.

ATTACHMENT I: ACTION ITEM FORMS

Action Item Forms

The action item forms portray the overall action plan framework and identify linkages between the plan goals, partnerships (coordination and partner organizations), and actions. Table BA-11 provides a list of actions for the city. The pages that follow include individual forms for each mitigation action.

Table BA-11 Mitigation Actions

Action Item	High Priority	Timeline	Status	Related Hazards							
				Drought	Earthquake	Flood	Landslide	Volcano	Wildfire	Windstorm	Winter Storm
MH #1		Long-Term	Ongoing		X	X	X	X	X	X	X
MH #2		Short-Term	Ongoing	X	X	X	X	X	X	X	X
MH #3	Yes	Long-Term	Deferred		X	X	X	X	X	X	X
MH #4	Yes	Short-Term	Ongoing	X	X	X	X	X	X	X	X
MH #5		Long-Term	Deferred	X	X	X	X	X	X	X	X
MH #6		Short-Term	Deferred	X	X	X	X	X	X	X	X
MH #7		Short-Term	Ongoing		X	X	X	X	X	X	X
EQ #1		Long-Term	Ongoing		X						
EQ #2		Long-Term	Deferred		X						
FL#1		Long-Term	Ongoing			X					
FL #2		Long-Term	Deferred			X					
FL #3		Long-Term	Deferred			X					
VE #1		Long-Term	Ongoing					X			
VE #2		Long-Term	Deferred					X			
WF #1		Short-Term	Complete						X		
WF #2	Yes	Short-Term	Deferred						X		
WF #3		Short-Term	Ongoing						X		
WF #4		Short-Term	Ongoing						X		
WF #5	Yes	Medium-Term	New						X		

Source: City of Bend NHMP Steering Committee

Mitigation Action: Multi-hazard #1 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Identify, improve, and sustain collaborative programs focusing on the real estate and insurance industries, public and private sector organizations, and individuals.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
This action is important to raise awareness about hazard mitigation with professions who regularly interact with homebuyers, home sellers, and those who finance real estate transactions.						
Ideas for Implementation (How will it get done?):				Action Status Report		
Provide background pieces, white papers, and/or information to local builder and realtors associations, local government communications professionals, and presentations to governing bodies.				Added in 2015; Ongoing in 2021		
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Police Department, Fire Department			Deschutes County Emergency Services, Deschutes County Rural Fire Protection District #2			
Potential Funding Sources:		Estimated cost:		Timeline:		
OEM (Public Private Partnership), DLCD, Local Funding Resources				<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Multi-hazard #2 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Develop public and private partnerships to foster natural hazard program coordination and collaboration.		<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
This action is important to ensure all agencies charged with or choosing to pursue natural hazards mitigation planning are coordinating efforts to be more effective and prevent duplication of efforts.						
Ideas for Implementation (How will it get done?):			Action Status Report			
			Added in 2015; Ongoing in 2021			
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Police Department, Bend Fire Department			Deschutes County Emergency Services, Deschutes County Rural Fire Protection District #2			
Potential Funding Sources:		Estimated cost:		Timeline:		
Local Funding Resources, County Emergency Manager				<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:	2015 NHMP Committee					
Action Item Status:	Ongoing					

Mitigation Action: Multi-hazard #3 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Develop inventories of at-risk buildings and infrastructure, and prioritize mitigation projects based on those providing the most benefit (at the least cost) to the population of the City of Bend.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input checked="" type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
DOGAMI RVS (2007), City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
<p>Retrofitting of vital infrastructure, such as schools, emergency service, and other community buildings, provides important improvements that reduce hazard exposure and the cost and time associated with recovery (Source: American Planning Advisory Service Report Number 483/484).</p> <p>The Disaster Mitigation Act of 2000 requires communities to identify actions and projects that reduce the effects of hazards on the community, particularly to buildings and infrastructure [201.6(c)(3)(ii)]. Identifying critical and essential facilities for retrofit will help to identify major infrastructure issues and appropriate mitigation actions to protect critical and essential facilities.</p>						
Ideas for Implementation (How will it get done?):			Action Status Report			
Conduct detailed structural evaluation that outlines recommendations for building deficiencies, and provides a cost estimate			Added in 2015; Deferred in 2021			
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Public Works, Engineering and Infrastructure, Bend Airport			Deschutes County Emergency Services, OEM, DOGAMI, FEMA, IFA			
Potential Funding Sources:			Estimated cost:		Timeline:	
Seismic Rehabilitation Grant Program, Flood Mitigation Assistance Grant Program, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program, Resource Assistance for Rural Environments					<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Deferred				

Mitigation Action: Multi-hazard #4 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Strengthen emergency services by maintaining the City of Bend Emergency Operations Plan, linking emergency services with hazard mitigation programs, and enhancing public education.		<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
The City of Bend last adopted the emergency operations plan or EOP in 2009. This action is important to update and maintain the plan so the City is prepared to respond effectively to natural hazards.						
Ideas for Implementation (How will it get done?):				Action Status Report		
Update the 2009 Bend EOP.				Added in 2015; Ongoing in 2021		
Champion/ Responsible Organization:		Bend Fire				
Internal Partners:			External Partners:			
Police, Fire, Public Works, City Administration			Deschutes County Emergency Services, Bend Park and Recreation District			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources, County Emergency Management/ NHMP Steering Committee					<input checked="" type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Multi-hazard #5 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Use technical knowledge of natural ecosystems and events to link natural resource management and land use organizations to mitigation activities and technical assistance.		<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
This action is important to help inform the next update to the Community Wildfire Protection Plan (CWPP). The CWPP was last updated in 2011. The recent work on the Bend urban growth boundary remand has highlighted the need to better link planning for natural hazard mitigation (e.g. wildfire) with long range planning for the City.						
Ideas for Implementation (How will it get done?):				Action Status Report		
				Added in 2015; Deferred in 2021		
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
			Deschutes County Emergency Services, Deschutes County Forester, DOGAMI, Oregon Water Resources, Oregon Department of Forestry			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources, County and City staff					<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Deferred				

Mitigation Action: Multi-hazard #6 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Develop benchmarks for a disaster-resistant and resilient community.		<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input checked="" type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
The State of Oregon the Oregon Resilience Plan in 2013, and is working to complete the State's Natural Hazards Mitigation Plan this year. This action is important to ensure consistency in benchmarking for hazard mitigation and resilience planning.						
Ideas for Implementation (How will it get done?):			Action Status Report			
Coordinate with County Community Development and cities to update comprehensive plans to include benchmarks in their Goal 7 plan elements			Added in 2015; Deferred in 2021			
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Police Department, Fire Department			Deschutes County Emergency Services, Deschutes County Community Development			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources, County and City staff, UO Community Service Center/ OPDR, OSU Cascades					<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Deferred				

Mitigation Action: Multi-hazard #7 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Develop and implement, or enhance, strategies for debris management for natural hazard (winter storm, wind, flood, etc.) events.		<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
Debris from natural hazards can be a potential threat to citizens, interfere with travel, and act as an attractive nuisance.						
Ideas for Implementation (How will it get done?):			Action Status Report			
Collaborate with County to create a joint debris removal plan.			Added in 2015; Ongoing in 2021			
Champion/ Responsible Organization:		Public Works				
Internal Partners:			External Partners:			
Police, Fire, Public Works Departments			Deschutes County Emergency Services, Deschutes County Rural Fire Protection District #2, Deschutes County Road Department, ODOT			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources, County Road Department, and City Public Works					<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Earthquake #1 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Seismically retrofit vulnerable facilities and infrastructure to increase their resiliency to seismic hazards. Consider both structural and non-structural retrofit options.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input checked="" type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
Ideas for Implementation (How will it get done?):			Action Status Report			
Conduct structural evaluations of critical and essential facilities (including historical buildings), and infrastructure and make recommendations (structural and non-structural) for fix. Align projects with regular maintenance programs.			Added in 2015; Ongoing in 2021			
Champion/ Responsible Organization:		Public Works/Utilities				
Internal Partners:			External Partners:			
Community Development, Engineering and Infrastructure Planning, Public Works			Deschutes County Community Development, Bend Park and Recreation District, Bend – La Pine Schools, Deschutes County Library			
Potential Funding Sources:			Estimated cost:		Timeline:	
Seismic Rehabilitation Grants (IFA), Local Funding Resources					<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Earthquake #2 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Improve local capabilities to perform earthquake building safety evaluations and to record and manage building inventory data.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
This action is important to ensure new construction and remodeling of existing buildings and structures can be constructed to withstand potential earthquakes.						
Ideas for Implementation (How will it get done?):			Action Status Report			
Coordinate training for local building officials, including plans examiners and building inspectors, to perform earthquake safety evaluations. Provide similar training to private building and home inspectors			Added in 2015; Deferred in 2021			
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Community Development, Engineering and Infrastructure Planning			Deschutes County Community Development, Deschutes County Emergency Services			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources, partner with County and Oregon Building Codes Division (BCD)					<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Deferred				

Mitigation Action: Flood #1 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Identify critical public infrastructure and facilities located in flood hazard areas and implement mitigation and preparedness measures for those facilities.		<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
The City has completed recent updates to its transportation (2013), water (2013), and sewer collection (2014) system plans. Completing this task will help inform the next round of updates to these plans that are expected to take place after the City completes work on the UGB Remand Project.						
Ideas for Implementation (How will it get done?):			Action Status Report			
Coordinate with County, ODOT, utilities, and irrigation districts to develop inventory of critical public infrastructure. Identify and program improvements to these facilities for mitigating flood hazards			Added in 2015; Ongoing in 2021			
Champion/ Responsible Organization:		Public Works/Utilities				
Internal Partners:			External Partners:			
Public Works, Engineering and Infrastructure Planning			Deschutes County: Community Development, Emergency Services, Road Departments; Oregon Department of Transportation			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources for identification, consider application for FEMA non-disaster mitigation grant					<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Flood #2 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Identify floodway obstructions and implement mitigation measures to remove obstructions.		<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
Ideas for Implementation (How will it get done?):			Action Status Report			
			Added in 2015; Deferred in 2021			
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Engineering and Infrastructure Planning			Deschutes County Community Development, Emergency Services, Roads; Oregon Department of State Lands, Oregon Department of Fish and Wildlife			
Potential Funding Sources:		Estimated cost:		Timeline:		
Local Funding Resources, Department of State Lands, Oregon Department of Fish and Wildlife				<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:	2015 NHMP Committee					
Action Item Status:	Deferred					

Mitigation Action: Flood #3 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Develop strategies to enhance the use of open space within the floodplain for flood mitigation, fish habitat, and water quality issues.		<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009)						
Rationale for Proposal (Why is this important?):						
Under Oregon planning law, the City's General Plan must address and satisfy Goals 5 (Open Spaces, Natural Areas, Habitat) and Goal 7 (Natural Hazards). This action is important because it provides an avenue for the City to address two goals with a set of strategies focused on flood mitigation.						
Ideas for Implementation (How will it get done?):			Action Status Report			
			Added in 2015; Deferred in 2021			
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Engineering and Infrastructure Planning, Community Development			Bend Park and Recreation District; Deschutes County Community Development; Oregon Department of State Lands, Oregon Department of Fish and Wildlife, DLCDC			
Potential Funding Sources:		Estimated cost:		Timeline:		
Local Funding Resources (City and County Planning with technical assistance from DLCDC)				<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:	2015 NHMP Committee					
Action Item Status:	Deferred					

Mitigation Action: Volcano #1 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Identify critical facilities and industries that may be affected by ash fall and develop and implement ash fall emergency response and mitigation projects.		<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009), Central Cascades Volcano Coordination Plan (2007) to be updated in 2015						
Rationale for Proposal (Why is this important?):						
Do not currently review volcanic activity						
Ideas for Implementation (How will it get done?):			Action Status Report			
Collaborate with owners/ operators of critical facilities and industries on ash fall emergency response and mitigation projects			Added in 2015; Ongoing in 2021			
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Engineering and Infrastructure Planning, Utilities, Streets			Deschutes County: Community Development, Emergency Services			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources, OSU Cascades, DOGAMI, USGS					<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Volcano #2 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Collaborate with the USGS's Cascade Volcano Observatory and related agencies to create ash fall warning messages that are more appropriate for Bend.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009), Central Cascades Volcano Coordination Plan (2007) to be updated in 2015						
Rationale for Proposal (Why is this important?):						
While not eminent, creating warning messages now will ensure the City and coordinating partners are ready to respond to a volcanic event.						
Ideas for Implementation (How will it get done?):			Action Status Report			
			Added in 2015; Deferred in 2021			
Champion/ Responsible Organization:		Community Development/Communications				
Internal Partners:			External Partners:			
Communications, Police, Fire			USGS, OSU-Cascades, OEM, Deschutes County Emergency Services, Deschutes County Communications, Deschutes County 911			
Potential Funding Sources:		Estimated cost:		Timeline:		
Local Funding Resources, OSU Cascades, DOGAMI, USGS				<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Deferred				

Mitigation Action: Wildfire #1 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Inventory alternative firefighting water sources and encourage the development of additional sources.		<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input checked="" type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009), Greater Bend CWPP (2011)						
Rationale for Proposal (Why is this important?):						
This action is important because it will help inform updates to both the Bend EOP and the Bend CWPP. The CWPP is intended to be updated every five years, with the next update coming up in sometime between 2016 and 2017.						
Ideas for Implementation (How will it get done?):			Action Status Report			
			Added in 2015; Complete in 2021			
Champion/ Responsible Organization:		Bend Fire				
Internal Partners:			External Partners:			
Fire Department, Engineering and Infrastructure Planning			County Forester, Project Wildfire, Deschutes County Emergency Services, Deschutes County 911			
Potential Funding Sources:		Estimated cost:		Timeline:		
Local Funding Resources (City/ County)				<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:	2015 NHMP Committee					
Action Item Status:	Complete					

Mitigation Action: Wildfire #2 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Encourage creation and adoption of wildland-urban interface maps to direct development requirements that assist wildfire mitigation.		<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input checked="" type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009), Greater Bend CWPP (2011)						
Rationale for Proposal (Why is this important?):						
HB 3623, encouraging the amendment to create inventories that expand beyond private lots development – i.e., Wildfire boundaries may be more expansive and not a clean line.						
Ideas for Implementation (How will it get done?):			Action Status Report			
Incorporate this work as a task in the next Community Wildfire Protection Plan for Bend (update 2011 CWPP)			Added in 2015; Deferred in 2021			
Champion/ Responsible Organization:		Bend Fire				
Internal Partners:			External Partners:			
Fire Department, Community Development, Information Technology (GIS)			Deschutes County Forester, Project Wildfire, Deschutes County Community Development, Deschutes County Emergency Services, Deschutes County 911			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources, Project Wildfire, Greater Bend CWPP					<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Deferred				

Mitigation Action: Wildfire #3 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Increase communication, coordination, and collaboration between wildland-urban interface property owners, city and county planners, and fire prevention crews and officials to address inherent risks in wildland-urban interface areas, available prevention/protection measures, and federal mitigation assistance programs.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009), Greater Bend CWPP (2011)						
Rationale for Proposal (Why is this important?):						
This action is important to improve communication and collaboration between agencies and staff involved with land development and planning (e.g. city and county planners) and those professionals working in wildfire mitigation and response. This is an opportunity to update the respective comprehensive plans and land use regulations of the cities and Deschutes County to ensure future development in wildland urban interface areas can occur to reduce and mitigate risks of wildfire.						
Ideas for Implementation (How will it get done?):				Action Status Report		
				Added in 2015; Ongoing in 2021		
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Community Development; Fire Department			Deschutes County Forester, Project Wildfire, Deschutes County Community Development; Deschutes County Rural Fire Protection District #2, Deschutes County Emergency Services			
Potential Funding Sources:			Estimated cost:		Timeline:	
ODF, Local Funding Resources, FEMA and other federal grant funding					<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Wildfire #4 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Implement fire mitigation activities in a manner consistent with the goals of promoting sustainable ecological management and community stability.		<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City of Bend EOP (2009), Greater Bend CWPP (2011)						
Rationale for Proposal (Why is this important?):						
This action is important to carry out any future mitigation developed through an updated to the Community Wildfire Protection Plan (CWPP). The CWPP was last updated in 2011. The next update should begin and be completed 2016-2017.						
Ideas for Implementation (How will it get done?):			Action Status Report			
			Added in 2015; Ongoing in 2021			
Champion/ Responsible Organization:		Code Enforcement				
Internal Partners:			External Partners:			
Community Development, Engineering and Infrastructure Planning			Deschutes County Forester, Project Wildfire, Deschutes County Community Development, Oregon Department of Land Conservation and Development, Oregon Department of Fish and Wildlife, USFS, BLM			
Potential Funding Sources:			Estimated cost:		Timeline:	
ODF, Local Funding Resources, FEMA and other federal grant funding, USFS, BLM					<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Action Item: WF#5 (What do we want to do?)		Alignment with Plan Goals:			High Priority Action Item?	
Wildfire Mitigation for Critical Water and Sewer Infrastructure		1 <input type="checkbox"/>	2 <input checked="" type="checkbox"/>	3 <input checked="" type="checkbox"/>	4 <input type="checkbox"/>	<input checked="" type="checkbox"/> Yes
		5 <input checked="" type="checkbox"/>	6 <input type="checkbox"/>	7 <input type="checkbox"/>	8 <input type="checkbox"/>	
		9 <input type="checkbox"/>	10 <input type="checkbox"/>	11 <input type="checkbox"/>		
		12 <input type="checkbox"/>	13 <input type="checkbox"/>	14 <input type="checkbox"/>		
Alignment with Existing Plans/Policies:						
City Water System Master Plan						
Rationale for Proposed Action Item (why is it important?):						
The City of Bend's water treatment facility and wastewater treatment facility are both located in areas with high wildfire risk. The water treatment facility is located within the Deschutes National Forest, and at risk for a forest fire. The sewage treatment facility is located north and east of Bend, and located in an area at risk for a brush fire. Both types of fire present risks to this critical infrastructure. The rationale for this action item is to identify and take steps to mitigate this risk around these facilities, and to take steps to also ensure facilities are fires resistant and can keep operating during a fire.						
Ideas for Implementation (how will it get done?):			Action Status Report			
City currently working on developing a new water system master plan. This idea can be incorporated as an implementation step to include in City's CIP for water projects. City starting work on updating facility plan for wastewater treatment plan later this year; this project provides the opportunity to evaluate wildfire risk to the treatment plant during the facility plan development.			Added in 2021			
Potential Funding Sources:		Estimated Cost:	Timeline:			
Local, state, federal Utility rate funded projects through CIPs			<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input checked="" type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)			
Coordinating/Lead Organization:		Bend Emergency Manager				
Internal Partners:			External Partners:			
City Public Works, Engineering Department			Deschutes County Planning, local fire departments, OEM, DLCD			
Form Submitted by:		Damian Syrnyk, City of Bend				
Action Item Status:		NEW				

ATTACHMENT 2: ACTION ITEM FORM TEMPLATE

Action Item: (What do we want to do?)	Alignment with Plan Goals:	High Priority Action Item?
	1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input type="checkbox"/> Yes
Alignment with Existing Plans/Policies:		
Rationale for Proposed Action Item (why is it important?):		
Ideas for Implementation (how will it get done?):	Action Status Report	
Potential Funding Sources:	Estimated Cost:	Timeline:
		<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)
Coordinating/Lead Organization:		
Internal Partners:	External Partners:	
Form Submitted by:		
Action Item Status		

CITY OF LA PINE ADDENDUM

Introduction

This document serves as the City of La Pine's Addendum to the Deschutes County Natural Hazards Mitigation Plan (NHMP). The City's Addendum is considered part of the County's multi-jurisdictional plan, and meets the following requirements: (1) Multi-jurisdictional Plan Adoption §201.6(c)(5), (2) Multi-jurisdictional Participation §201.6(a)(3), (3) Multi-Jurisdictional Risk Assessment §201.6(c)(2) (iii), and (4) Multi-jurisdictional Mitigation Strategy §201.6(c)(3)(iv).

A description of the city specific planning and adoption process follows, along with detailed community specific action items; for detailed information see Volume IV, Appendix B. Information about the city's risk relative to the County's risk to natural hazards is documented in this addendum's Hazard Analysis and Issue Identification section. The section considers how the city's risk differs from or matches that of the County's; additional information on Risk Assessment is provided within Volume I, Section 2 of this NHMP.

How was the Plan Developed?

The NHMP was developed by the Deschutes County Natural Hazards Mitigation Plan steering committee, while this addendum was created by the City of La Pine steering committee. The Deschutes County Emergency Manager was designated as the NHMP's convener and will take the lead in implementing, maintaining and updating the plan. Locally, City Planning Staff and the City Manager's office convened a steering committee for the purpose of developing the city's addendum.

The local steering committee was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. The local steering committee met on one occasion: April 8th, 2021 (see Appendix B for more information). Steering committee members contributed data and reviewed, and provided guidance towards the community profile, risk assessment, mitigation strategy (action items), and implementation and maintenance plan. The addendum reflects effort from the formal meeting and during subsequent informal meetings between members of the steering committee and with Central Oregon Intergovernmental Council (COIC) facilitators.

An open public involvement process is essential to the development of an effective plan. In order to develop a comprehensive approach to reducing the effects of natural disasters, the planning process should include opportunities for the public, neighboring communities, local and regional agencies, as well as private and nonprofit entities to comment on the plan.¹ COIC provided a publicly accessible project webpage for the general public in order to make meeting materials and contact information available throughout the update process. In addition,

¹ Code of Federal Regulations, Chapter 44. Section 201.6, subsection (b). 2015

Deschutes County and the City of La Pine provided press releases on their websites to encourage the public to offer feedback on the plan update.

In addition, COIC administered a public opinion survey to obtain additional input from the public regarding the County’s risks, vulnerabilities, hazards history, and mitigation strategies. See Volume IV, Appendix F for more information.

Updating the mitigation plan is a requirement to gain eligibility for the Federal Emergency Management Agency’s Pre-Disaster Mitigation, Hazard Mitigation, and Flood Mitigation Assistance grant Programs. This project is funded through the Federal Emergency Management Agency’s (FEMA) FY12 Pre-Disaster Mitigation Competitive Grant Program (PDMC – PL-10-OR-2012-002).

The La Pine Addendum to the Deschutes County NHMP was adopted on October 27, 2021 and approved by FEMA on October 28, 2021. The Deschutes MNHMP was approved by FEMA on October 28, 2021, the plan is effective for Deschutes County and La Pine through October 27, 2026.

For more information on the composition of the steering committee and the process see this NHMP’s Volume I, Acknowledgements and Executive Summary, and Volume IV, Appendix B.

Action Item Matrix

The City’s action items were first developed through a two-stage process in 2015 by the local steering committee, facilitated by Oregon Partnership for Disaster Resilience (OPDR). In 2021, the local steering committee, facilitated by COIC, updated the status of existing action items and added one new action item. In addition, there are 23 County Action Items that include La Pine as an “Affected Jurisdiction.” For additional information see the discussion near the end of this document.

The City’s actions are listed below in matrix format. For more detailed information on each action, see the action forms within Attachment 1 of this addendum.

Table LA-1 City of La Pine Action Items

2021 Action Item	High Priority	Mitigation Action Title	Lead Organization	Partner Organization(s)	Timeline	Status
Multi-Hazard #1 <i>(previously Winter Storm #1)</i>		Support local electric cooperative and seek funding to protect highest risk utility lines. Harden key infrastructure.	City Administration, Public Works	Internal: Planning External: Deschutes County, MidState Electric Cooperative	Long-Term	Ongoing
Multi-hazard #2	X	Explore options to create a cluster sewer system for La Pine and the area of the county between La Pine and Sunriver.	City Administration, Public Works	Internal: Planning, Finance, Legal External: DEQ, Deschutes County	Short-Term	Removed
Multi-hazard #3	X	Improve existing sewer effluent leach field to mitigate concerns due to high groundwater.	City Administration, Public Works	Internal: Planning External: DEQ, Deschutes County	Short-Term	Removed
Drought #1	X	Improve water supply and delivery systems to reduce vulnerability by acquiring additional water rights and providing a second water line from the city's reservoir, wells, and pumps. Improvements should be designed to accommodate drought events.	City Administration and Public Works: Contract Legal services	Internal: Planning Department, Finance Department External: OWRD, DEQ, EPA, Deschutes County	Long-Term	Ongoing
Flood #1		Identify drainage areas to provide better stormwater drainage in core area due to rain or snow events.	City Administration, Public Works	Internal: Planning External: DEQ, Deschutes County	Long-Term	Complete
Wildfire #1	X	Support projects to reduce fuel inside and adjacent to city to provide buffer zones around populated areas.	City Administration, Public Works, Fire Department	Internal: Planning External: Deschutes County	Ongoing	Removed
NEW Wildfire #2	X	Support projects to reduce risk of hazardous wildfires inside and adjacent to city in wildland-urban interface areas by: a. Improving forest health & resiliency b. Hardening communities and structures c. Fire prevention d. Suppression support	City Administration, Public Works, Fire Department	Internal: Planning External: Deschutes County, USFS/BLM, City	Ongoing	New

Source: City of La Pine NHMP Steering Committee, 2021

How Will the Plan be Implemented?

The City Council will be responsible for adopting the City of La Pine addendum to the Deschutes County NHMP. This addendum designates a coordinating body and a convener to oversee the development and implementation of action items. Because the city addendum is considered part of the County plan, the city will look for opportunities to partner with the County to maintain the plan, and coordinate mitigation efforts through the implementation of action items, etc. The City’s steering committee will convene after re-adoption of the City of La Pine addendum annually with the County every spring. For more details on the meeting schedule and process, see Volume I, Section 4. The City Manager or their designee will serve as the convener and will be responsible for convening the local steering committee. The convener will also remain active in the County’s planning process. The steering committee will seek to involve senior staff and decision makers throughout the duration of the five-year implementation and maintenance of the NHMP addendum.

Implementation through Existing Programs

Many of the Natural Hazards Mitigation Plan’s recommendations are consistent with the goals and objectives of the city’s existing plans and policies. Where possible, the City of La Pine will implement the NHMP’s recommended actions through existing plans and policies. Plans and policies already in existence have support from local residents, businesses, and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, allowing them to adapt to changing conditions and needs. Implementing the NHMP’s action items through such plans and policies increases their likelihood of being supported and implemented.

The City of La Pine currently has the following plans that relate to natural hazard mitigation:

Table LA-2 Existing Plans

Jurisdiction	Document	Year
City of La Pine	Comprehensive Plan	2018
City of La Pine	Development Code (Flood, Section 9.12)	2012
City of La Pine	Transportation System Plan	2013
City of La Pine	Greater La Pine CWPP	2020
City of La Pine	Water System Capital Facilities Plan	2016

Source: City of La Pine, 2021

The steering committee and the community’s leadership have the option to add or implement action items at any time. This allows the steering committee to consider mitigation strategies as new opportunities arise, such as funding for action items that may not be of the highest priority. When new actions are identified, they should be documented using an action item form (see Attachment 2). Once a proposed action form has been submitted to the convener, the action will become part of the City’s addendum.

Continued Public Participation

Keeping the public informed of the city's efforts to reduce the city's risk to future natural hazards events is important for successful plan implementation and maintenance. The city is committed to involving the public in the plan review and updated process. The City Addendum along with the County Plan will be posted on-line on COIC's website (<https://www.coic.org/emergency-preparedness/natural-hazard-mitigation-plans/deschutes-county-nhmp/>), as well as the County and City websites, so that the public may view the plan at any time.

In addition, natural hazards information dissemination is conducted throughout the year when opportunities present themselves via the city offices and website.

Plan Maintenance

The Deschutes County Natural Hazards Mitigation Plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the County plan update process, the city will also review and update its addendum. The convener will be responsible for convening the steering committee to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help the steering committee determine what components of the mitigation plan need updating. The steering committee will be responsible for updating any deficiencies found in the plan.

The remainder of this addendum includes three sections:

1. Community Profile and Asset Identification,
2. Hazard Identification and Risk Assessment, and
3. Mitigation Strategy section.

COMMUNITY PROFILE

ASSET IDENTIFICATION

This section provides city specific asset identification. For information on the characteristics of La Pine, in terms of geography, environment, population, demographics, employment and economics, as well as housing and transportation see Volume IV, Appendix C, *Community Profile*. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

We live in a place with a varied geography and communities. We would like to recognize and acknowledge the indigenous land of the Confederated Tribes of Warm Springs, Molalla, Paiute, Klamath, Modok, Yahooskin Band of Snake Indians, and Tribes of Middle Oregon. We want to recognize the people that came before us and honor their traditions and stewardship of the land. Acknowledgement is a simple, powerful way of showing respect for Indigenous People's history and culture.

Asset Identification

The following assets were identified by the steering committee in 2021:

Critical and Essential Facilities

- Deschutes County Sheriff's Office Emergency Management has access to an inventory of critical and essential facilities.

Deschutes County, State, and Federal Critical and Essential Facilities (located in La Pine):

- Deschutes County Sheriff's Office Substation – 51340 US-97

Special Districts with Offices in La Pine

- Midstate Electric Cooperative, Inc. – 16755 Finley Butte Road
- La Pine Rural Fire Protection District
 - Station 101 (Main) - 51550 Huntington Road
 - Station 103 – 15990 Burgess Road

La Pine School District

- La Pine Elementary School – 51615 Coach Road
- Rosland Elementary School – 52350 Yaeger Way
- La Pine Middle School – 16360 First Street
- La Pine Senior High School – 51633 Coach Road

Social Service Providers

- Please see <https://www.thrivecentraloregon.org/services> for a comprehensive list of resource providers throughout Central Oregon, including La Pine.

Population

La Pine's estimated population as of December 15, 2020 is 2,005 people. The city's population has grown an estimated 370 people or 23.0% since the 2010 Census.² La Pine's acknowledged Coordinated Population Forecast is 2,352 people by the year 2025, which represents an increase of 682 people or 41% between 2013 and 2025.³

Land Use

The City of La Pine incorporated in 2006 and it's acknowledged comprehensive plan is the "City of La Pine Comprehensive Plan". The Oregon Land Conservation and Development Commission first acknowledged the plan in 2010. The City implements the plan through the La Pine Development Code, which was last updated in 2020. The current zoning map for La Pine can be found at the City of La Pine's Planning Commission [webpage](#).

La Pine has lower property values, as measured against the other incorporated communities of Deschutes County, and a high demand for a greater variety of housing and employment. Recent development trends include establishment of an Urban Renewal District in 2014, and the rapid expansion of platted and recorded subdivisions and accompanying single family and multifamily developments

Parks and Open Space

The La Pine Park and Recreation District operates and maintains ten parks, open spaces, and facilities.⁴ The city's parks include Audia Park, Finley Butte Sports Complex, La Pine Community Park, Frontier Heritage Park, Leona Park, Rosland Campground and the John C. Johnson building, La Pine Community Center, and the La Pine Skate Park. Additionally the La Pine Senior Activity Center is another community asset that is maintained under a community 501(c)3.

Economy

La Pine is the smallest city in Deschutes County and has the lowest rate of growth, however, the population is expected to grow by 40% by 2032. The community is dominated by small employers and the La Pine Industrial Park contains over 150 available acres of state-certified, shovel-ready parcels.⁵

² Portland State University, Population Research Center, "Annual Population Estimates", 2010, 2020.

³ 2018-2068 Coordinated Population Forecast for Deschutes County – 2018

⁴ La Pine Park and Recreation Website: <http://www.lapineparks.org>, accessed April 5, 2021.

⁵ State of Oregon Employment Department: News.

(<https://www.qualityinfo.org/documents/10182/73818/Labor+Force+and+Unemployment+by+Area?version=1.88>)

The seasonally adjusted unemployment rate for Deschutes County was 6.8% in December 2020. The number of employed persons was 90,278, and the civilian labor force was 96,841.⁶

Cultural and Historic Resources

The sites and structures listed below (Table LA-3) represent the city’s official list of historic places compiled by the city and County, and approved by the Oregon Land Conservation and Development Commission.

Table LA-3 List of Historic and Cultural Resources – City of La Pine

Historic Site/ Name	Location
Pioneer Hall/ La Pine Commercial Club/ Little Deschutes Grange 939	51518 Morson Street
Improved Order of Red Men Cemetery (La Pine Cemetery)	17200 Reed Road

Source: City of La Pine Comprehensive Plan (2018)

⁶ <https://www.edcoinfo.com/>, accessed April 5, 2021.

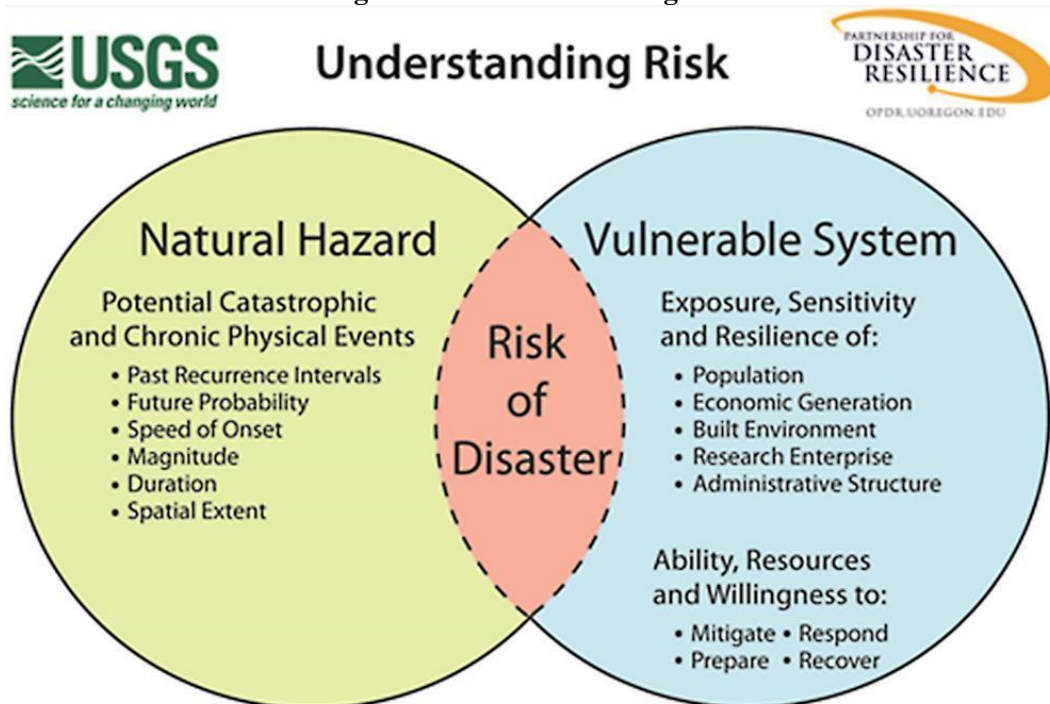
RISK ASSESSMENT

This section of the NHMP addendum addresses 44 CFR 201.6(b)(2) - Risk Assessment. In addition, this chapter can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – Areas Subject to Natural Hazards. Assessing natural hazard risk has three phases:

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

The information presented below, along with hazard specific information presented elsewhere in this addendum, within the Hazard Annexes (Volume II), and community characteristics presented in the Community Profile (Appendix C), will be used as the local level rationale for the risk reduction actions identified in this addendum. The risk assessment process is graphically depicted in Figure LA-1 below. Ultimately, the goal of hazard mitigation is to reduce the area where hazards overlap vulnerable systems.

Figure LA-1 Understanding Risk



Source: Oregon Partnership for Disaster Resilience

Hazard Analysis Methodology

This NHMP utilizes a hazard analysis methodology that was first developed by FEMA circa 1983, and gradually refined by the Oregon Military Department’s Office 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%.

This 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 shown in the table below. See Volume I, Section 3 (Risk Assessment) for more information.

Hazard Analysis

On April 8th, 2021, the City of La Pine addendum steering committee developed their hazard vulnerability assessment (HVA), using the County’s HVA as a reference. Changes from the County’s HVA were made where appropriate to reflect distinctions in vulnerability and risk from natural hazards unique to the City of La Pine, which are discussed throughout this addendum.

Table LA-4 shows the HVA matrix for La Pine showing each hazard listed in order of rank from high to low. For local governments, conducting the hazard analysis is a useful step in planning for hazard mitigation, response, and recovery. The method provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard.

Table LA-4 Hazard Analysis Matrix – City of La Pine

Hazard	Maximum				Total Threat Score	Hazard Rank	
	History	Vulnerability	Threat	Probability			
Wildfire	20	50	100	70	240	# 1	Top Tier
Winter Storm	18	50	100	70	238	# 2	
Windstorm	18	50	50	70	188	# 3	
Volcano	2	50	100	21	173	# 4	Middle Tier
Drought	10	20	90	35	155	# 5	
Earthquake (Cascadia)	2	40	100	7	149	# 6	Bottom Tier
Flood	8	50	30	14	102	# 7	
Earthquake (Crustal)	4	20	80	14	118	# 8	
Landslide	2	5	10	7	24	# 9	

Source: City of La Pine NHMP Steering Committee, 2021.

Three chronic hazards (wildfire, winter storm, and windstorm) and one catastrophic hazard (volcano) rank as the top four hazard threats to the city (Top Tier). The drought and Cascadia earthquake hazards comprise the next two highest ranked hazards (Middle Tier), while the

flood, crustal earthquake, and landslide hazards comprise the lowest ranked hazards (Bottom Tier).

Table LA-5 categorizes the probability and vulnerability scores from the hazard analysis for the city and compares the results to the assessment completed by the Deschutes County NHMP Steering Committee (areas of differences are noted with **bold** text within the city ratings).

Table LA-5 Probability and Vulnerability Comparison

Hazard	La Pine		County	
	Probability	Vulnerability	Probability	Vulnerability
Drought	Moderate	Moderate	High	Low
Earthquake (Cascadia)	Low	High	Low	High
Earthquake (Crustal)	Low	Moderate	Low	Moderate
Flood	Low	High	High	Low
Landslide	Low	Low	Moderate	Low
Volcano	Low	High	Low	High
Wildfire	High	High	High	High
Windstorm	High	High	High	High
Winter Storm	High	High	High	High

Source: City of La Pine NHMP Steering Committee and Deschutes County NHMP Steering Committee, 2021.

Drought

A drought is a period of drier than normal conditions that results in water-related problems. 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.

The steering committee determined that the city’s probability for drought is **moderate** (which is lower than the County’s rating) and that their vulnerability to drought is **moderate** (which is higher than the County’s rating).

The City has two water supply wells (Wells 1A and 2B), both located adjacent to the 1.2 million gallon (MG) reservoir on Finley Butte Road (Finley Butte Reservoir). Each well has a pumping capacity of 650 gallons per minute (gpm). The wells are located on City-owned property, approximately 1.5 miles east of La Pine. According to well log data, the wells are 252 and 254 feet deep, respectively, and have been the sole water source for the City (formerly the La Pine Water District) for the past 13 years. When pump tested, the wells were each capable of providing 1,300 gpm of water, with drawdown depths of 24 and 13 feet, respectively. If both wells are pumped at the same time, at the capacity of 650 gpm each of the wells will experience a drawdown of 5 ft. but then recover at a static level within 7 minutes. If demands require utilizing both wells at once, the City should closely monitor the impacts to static water levels in the aquifer. ⁷

⁷ La Pine Water System Study Update 2016, accessed April 5, 2021

The City's wells are not located in an area designated by the Oregon Water Resources Department (OWRD) as critical groundwater or groundwater limited. The City of La Pine holds several water rights issued by the State of Oregon for its groundwater sources. For Wells 1A and 2B, a secondary application has been submitted, but the City must provide 405.2 mitigation credits before a permit will be issued. The City also holds a permit for Well 1 and Well 2 located at the City of La Pine's wastewater treatment facility. This water is currently allowed for irrigation use only.⁸

Both Wells 1A and 2b are supported by a single unit backup power source on site. Impacts from a prolonged drought are likely to include an increased demand for water for irrigation and fire prevention and control. The city currently provides information to residents on how to conserve water and has a curtailment plan for critical emergencies that may include curtailing outside watering and mandate voluntary water reduction measures.

For more information on the Drought Hazard (including history and extent) see the Drought Annex in Volume II.

Earthquake

Oregon and the Pacific Northwest in general are susceptible to earthquakes from four sources: 1) the off-shore Cascadia Fault 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.⁹

The areas most susceptible to ground amplification and liquefaction have young, soft alluvial sediments, found along river and stream channels. The extent of the damage to structures and injury and death to people will depend upon the type of earthquake, proximity to the epicenter and the magnitude and duration of the event.

The steering committee HVA evaluated both crustal earthquakes and a Cascadia earthquake. The steering committee determined that the city's probability of experiencing a crustal earthquake is **low** (which is the same as the County's rating) and that their vulnerability to a crustal earthquake is **moderate** (which is the same as the County's rating). The steering committee determined that the city's (and State's) probability of experiencing a Cascadia earthquake is **low** (which is the same as the County's rating) and that their vulnerability to a Cascadia earthquake is **high** (which is the same as the County's rating).

Sixty-percent of La Pine's building stock was built after 1990 and the codification of seismic codes. La Pine's soil characteristics lends itself to liquefaction susceptibility and is expected to experience very strong to violent shaking in an earthquake event (see Volume II, Tables II-5 and II-6). As such, the city's vulnerability to earthquakes is higher than other areas of the County because of the area's geology; however, the city's relatively new infrastructure and buildings are relatively resistant to earthquake shaking. The city considers itself to have high vulnerability to a Cascadia earthquake event due to secondary effects of the hazard, including access to transportation routes, energy resources, communications, and the need to assist with refugees of the damage that is expected west of the Cascades.

⁸ City of La Pine Website, accessed April 5, 2021.

⁹ Taylor, George H. and Chris Hannan. The Oregon Weather Book. Corvallis, OR: Oregon State University Press. 1999

Information on specific buildings' estimated seismic resistance, determined by DOGAMI in 2007, is shown in Tables LA-6 below. The table displays the rankings of all facilities within the city's jurisdiction; each "X" represents one building within that ranking category. These scores have not been updated since 2007, but any new buildings can be assumed "low" risk given new building codes.

Of the school facilities evaluated by DOGAMI using RVS, all three have buildings with very high (100% chance) collapse potential. Of the public safety facilities evaluated, two (2) have very high (100% chance) collapse potential; including the La Pine RFPD and the Deschutes County Sheriff's Office.

Table LA-6 Rapid Visual Survey Scores

Facility	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Schools				
La Pine Elementary School (51615 Coach Rd, La Pine)				X
La Pine Middle School (16360 First St, La Pine)	X			X
La Pine Senior High School (51633 Coach Rd, La Pine) - Addition Classroom (Aug. 2010)	X			X
Public Safety				
La Pine RFPD (51550 Huntington Way, La Pine)	X			X
La Pine RFPD (15990 Burgess Rd, La Pine)			X	
Deschutes County Sherriff's Office (51340 HWY 97, La Pine)				X

Source: DOGAMI 2007. Open File Report 0-07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.

The County and cities have opted to create one action item for all the facilities that have a "high" or "very high" rating (see Appendix A). The buildings with 'high' or 'very high' collapse potential include multiple education facilities located throughout the city, all of which can play a key role in/during disaster events or during long-term recovery.

For more information on the Earthquake Hazard (including history and extent) see the Earthquake Annex in Volume II.

Flood

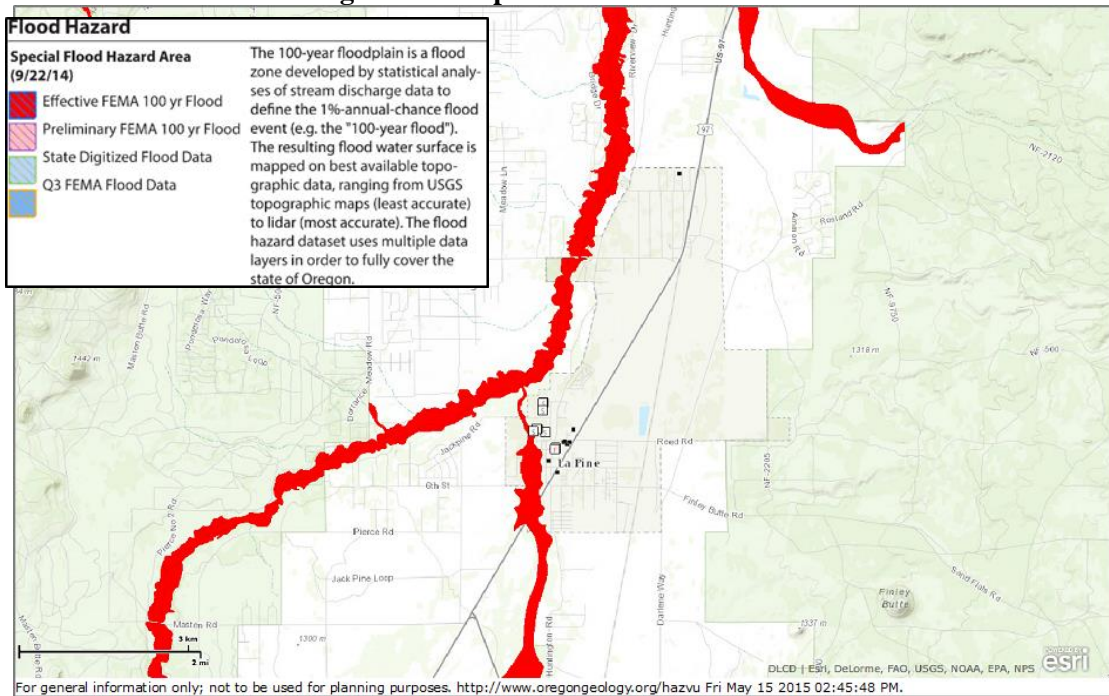
Flooding results when rain and snowmelt creates water flow that exceeds the carrying capacity of rivers, streams, channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall.

Most of Oregon’s destructive natural disasters have been floods.¹⁰ Flooding can be aggravated when rain is accompanied by snowmelt and frozen ground; the spring cycle of melting snow is the most common source of flood in the region. The principal types of flood that occur in La Pine include: spring/snowmelt flooding, warm winter rain-on-snow flooding, ice jams, flash floods, and dam failure.

The steering committee determined that the city’s probability for flood is **low** (which is lower than the County’s rating) and that their vulnerability to flood is **high** (which is higher than the County’s rating).

The city’s principal flood concern is from the Little Deschutes River which passes through the southwest corner of the city and has a flood season that extends from October through June (the majority of the large events occur from April through June). The largest flood event occurred in December 1964, with a peak discharge of 3,660 cfs about 1.5 miles north of La Pine; this event was considered a 500-year flood event (0.2-percent-annual-chance-flood).¹¹ The next two largest flood events occurred in June 1950 and May 1956 both with discharges of 1,320 cfs (25-year flood occurrence interval). These floods were considered nuisance floods and did not cause significant damage in part due to the undeveloped character of the floodplain. La Pine has a portion of its community that is developed near the special flood hazard area, however, the development is outside of the floodplain (see Figures LA-2 below).

Figure LA-2 Special Flood Hazard Area



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu), accessed May 15, 2015

¹⁰ Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. 1999

¹¹ Deschutes County Flood Insurance Study (2007)

National Flood Insurance Program (NFIP)

The Deschutes County Flood Insurance Rate Maps (FIRMs) were modernized in 2007. The table below shows that as of November 2014, La Pine has one (1) National Flood Insurance Program (NFIP) policy in force for a single-family home and has zero (0) paid claims. The city has not had a Community Assistance Visit (CAV) and is not a member of the Community Rating System (CRS). Additionally, the community repetitive flood loss record for La Pine does not include any repetitive flood loss, or severe repetitive flood loss, buildings and has not had any repetitive loss claims.

Table LA-7 Food Insurance Detail

Jurisdiction	Current FIRM Date	Initial FIRM Date	Total Policies	Pre-FIRM Policies	Policies by Building Type				Minus Rated A Zone
					Single Family	2 to 4 Family	Other Residential	Non-Residential	
La Pine	9/28/2007	9/28/2007	1	1	1	0	0	0	0

Jurisdiction	Insurance in Force	Total Paid Claims	Pre-FIRM Claims Paid	Substantial Damage Claims	Repetitive Loss Buildings	Severe Repetitive Loss Buildings	Total Paid Amount	CRS Class Rating	Last CAV

Source: Information compiled by Department of Land Conservation and Development, November 2014.

For more information on the Flood Hazard (including history and extent) see the Flood Annex in Volume II.

Landslide

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.

The steering committee determined that the city's probability for landslide is **low** (which is lower than the County's rating) and that their vulnerability to landslide is **low** (which is the same as the County's rating).

The city has had no problems with landslides in city limits in known history and is located in a generally stable area.

For more information on the Landslide Hazard (including history and extent) see the Landslide Annex in Volume II.

Volcano

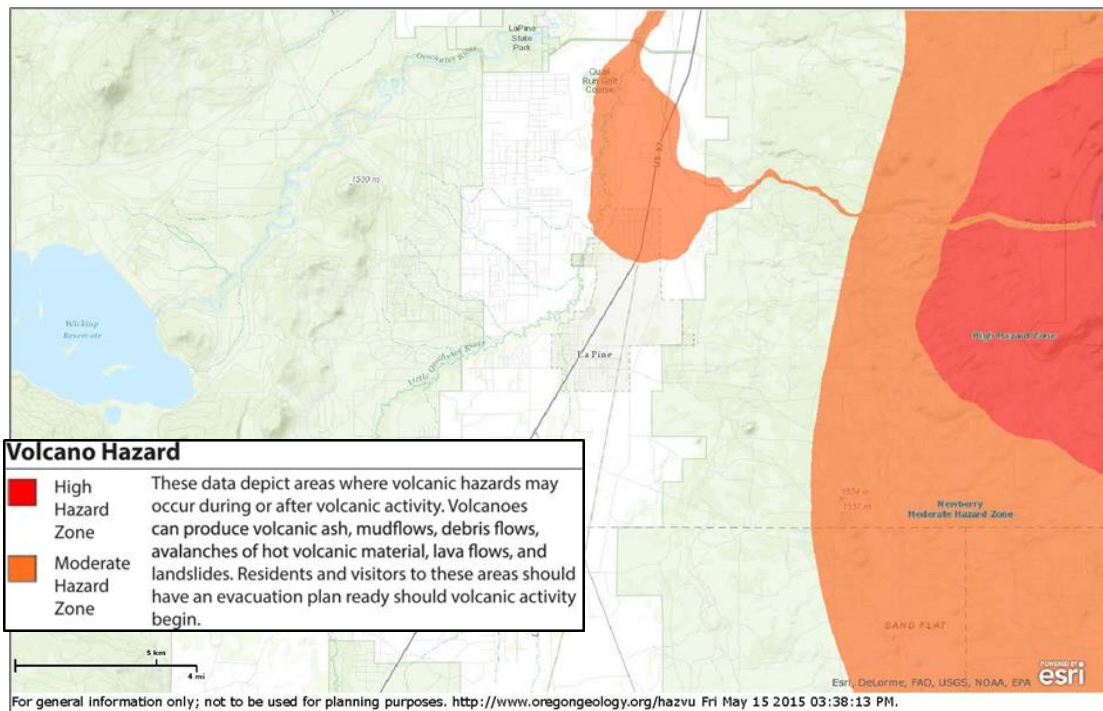
The Pacific Northwest lies within the "ring of fire", an area of very active volcanic activity surrounding the Pacific Basin. Volcanic events occur regularly along the ring of fire, in part because of the movement of the Earth's tectonic plates. Volcanic events have the potential to

coincide with numerous other hazards including ash fall, earthquakes, lava flows, pyroclastic flows, lahars, and debris flows, and landslides.

The steering committee determined that the city’s probability for volcanic events is **low** (which is the same as the County’s rating) and that their vulnerability to volcanic events is **high** (which is the same as the County’s rating).

Were a volcanic event to occur in the Cascades region of Oregon, La Pine could be at risk for ash fall, regional lava flows, and lahars, depending on the severity of the event and the direction of the wind. Due to La Pine’s proximity to Newberry Crater, in relation to other areas within eastern Oregon, the effects of a volcanic event may be more disruptive to normal business, economic activity, and health than to other regions of the County. Figure LA-3 shows the regional volcano hazards that indicate that La Pine is within a moderate hazard zone; see also Figure II-16 within Volume II, *Hazard Annexes*.

Figure LA-3 Volcano Hazards



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu), accessed May 15, 2015

For more information on the Volcano Hazard (including history and extent) see the Volcano Annex in Volume II.

Wildfire

Wildfires occur in areas with large amounts of flammable vegetation that require a suppression response due to uncontrolled burning. Fire is an essential part of Oregon’s ecosystem, but can also pose a serious threat to life and property particularly in the state’s growing rural communities. Wildfire can be divided into three categories: interface, wildland, and firestorms. The increase in residential development in interface areas has resulted in greater wildfire risk.

Fire has historically been a natural wildland element and can sweep through vegetation that is adjacent to a combustible home. New residents in remote locations are often surprised to learn that in moving away from built-up urban areas, they have also left behind readily available fire services providing structural protection.

The steering committee determined that the city's probability for wildfire is **high** (which is the same as the County's rating) and that their vulnerability to wildfire is **high** (which is the same as the County's rating).

Wildfires occur regularly in the vicinity of La Pine; recent fires that have significantly impacted La Pine include the Bridge Dive in 2019 (12 acres, 2 structures), Burgess Road in 2018 (3 acres, 1 structure) and in 2013 (168 acres), Park Fire in 2005 (139 acres), Davis Lake in 2003 (21,181 acres), Crane Complex in 2001 (713 acres), and Pine Forest in 2001 (120 acres); for a complete list of recent large wildfires see Table II-7 and Figure II-19) within Volume II, Hazard Annex. The Greater La Pine Country Community Wildfire Protection Plan (CWPP, 2020) relies upon (1) the Oregon Department of Forestry Assessment of Risk Factors and (2) the classification ratings of individual areas under the Oregon Forestland-Urban Interface Fire Protection Act of 1997 (Senate Bill 360) to determine fire risk within the Greater La Pine Wildland-Urban Interface (WUI). According to the Senate Bill 360 ratings the City of La Pine WUI (see map in Attachment 3) rated as High to Extreme fire risk; and according to the ODF Assessment the City of La Pine WUI is rated with a **high** probability of wildfire risk occurring and **high** vulnerability¹². The City of La Pine is rated as a "Higher" (Next Highest Priority) Risk Priority Community for hazardous fuel treatments within the CWPP.¹³ For more information on wildfire risk and fuels reduction projects see the Greater La Pine Country CWPP and visit the Project Wildfire website: <http://www.projectwildfire.org/>.

For more information on the Wildfire Hazard (including history and extent) see the Wildfire Annex in Volume II and the Greater La Pine Country CWPP.

Windstorm

Winds associated with thunderstorms are short-lived, but strong winds not associated with thunderstorms can last several hours. Although windstorms can affect the entirety of Deschutes 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.

The steering committee determined that the city's probability for windstorm is **high** (which is the same as the County's rating) and that their vulnerability to windstorm is **high** (which is the same as the County's rating).

Historical wind events have uprooted trees, damaged roofs and windows, and damaged utility lines. Windstorms have not caused disastrous local damage but are a persistent problem. Windstorms are often associated with microbursts (thunderstorms). A primary windstorm

¹² The ODF Assessment takes into account the likelihood of a fire occurring, hazard rating, protection capability, human and economic values protected, structural vulnerability to determine the overall score. For detailed information review the CWPP available on the Project Wildfire website: <http://www.projectwildfire.org/>

¹³ Greater La Pine Country CWPP, 2020.

vulnerability for the community is damage to utility lines, including fiber optics, which are key to the economic sectors of the community.

For more information on the Windstorm Hazard (including history and extent) see the Windstorm Annex in Volume II.

Winter Storm

Severe winter storms can consist of rain, freezing rain, ice, snow, cold temperatures, and wind. They originate from troughs of low pressure offshore that ride along the jet stream during fall, winter, and early spring months. Severe winter storms affecting Deschutes County typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from November through March.

The steering committee determined that the city's probability for winter storm is **high** (which is the same as the County's rating) and that their vulnerability to winter storm is **high** (which is the same as the County's rating).

La Pine is located near the eastern slope of the Cascade Mountain Range. Major winter storms can and have occurred in the La Pine area, and while they typically do not cause significant damage; they are frequent and have the potential to impact economic activity. Road closures on Highway 97, or the passes to the Willamette Valley (Highways 58, 20, and 26), due to winter weather are a common occurrence and can interrupt commuter and large truck traffic. The city budgets funds for seasonal winter storm needs, such as clearing roads.

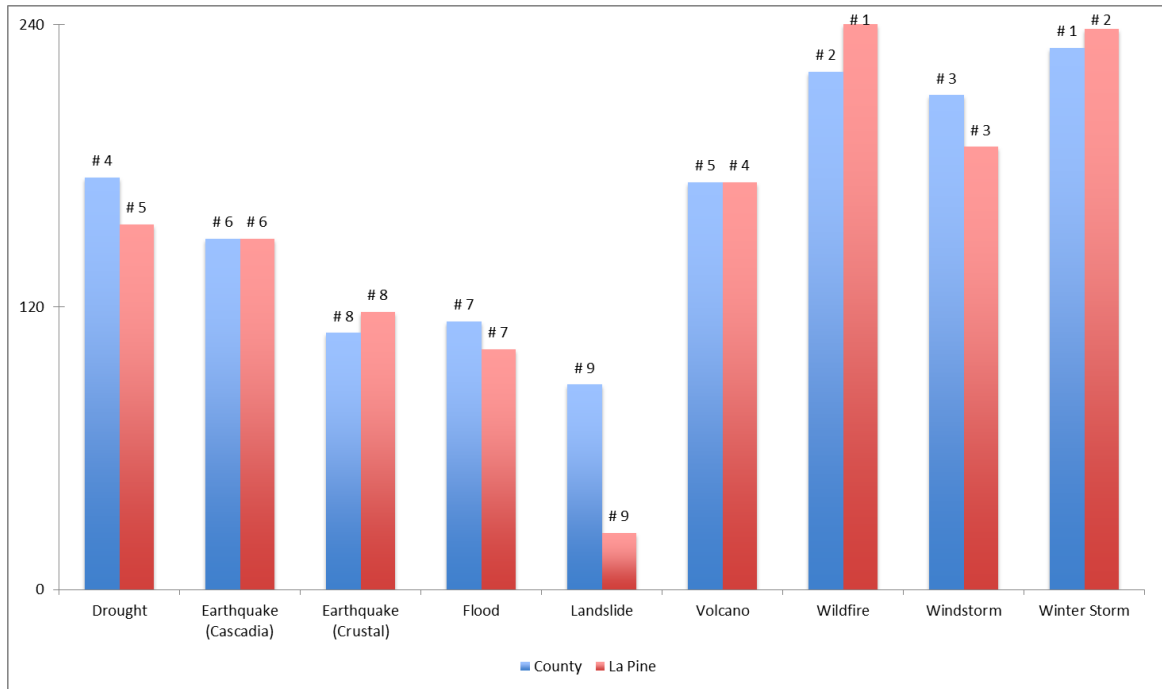
For more information on the Winter Storm Hazard (including history and extent) see the Winter Storm Annex in Volume II.

Summary

The figure below presents a summary of the hazard analysis for the City of La Pine and compares the results to the assessment completed by the Deschutes County NHMP Steering Committee.

In terms of history, probability, vulnerability, and maximum threat, the hazard analysis for the city overall rated their threat to the crustal earthquake, wildfire, and winter storm hazards higher than the County; and the drought, flood, landslide, and windstorm hazards were rated lower than the County. All other hazards were rated the same as the County's ratings.

Figure LA-4 Overall Hazard Analysis Comparison – La Pine and Deschutes County



Source: City of La Pine NHMP Steering Committee and Deschutes County NHMP Steering Committee, 2021.

Mitigation Plan Mission

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

The mission of the Deschutes County NHMP is:

To promote sound public policy designed to protect people, critical facilities, infrastructure, property, and the environment from natural hazards.

This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the County towards building a safer, more disaster resistant community.

The La Pine steering committee reviewed the 2021 NHMP plan mission statement and agreed it accurately describes the overall purpose and intent of this plan. The steering committee believes the concise nature of the mission statement allows for a comprehensive approach to mitigation planning.

Mitigation Plan Goals

Mitigation plan goals are more specific statements of direction that Deschutes 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.

The La Pine Addendum steering committee reviewed and agreed to the 2021 Deschutes County NHMP plan goals. 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 to implement first, should funding become available. Below is a list of the 2021 NHMP goals:

Goal 1 - Protect life and reduce injuries resulting from natural hazards.

Goal 2 - Minimize property damage from natural hazards.

Goal 3 - Minimize damage to critical or essential infrastructure and services from natural hazards.

Goal 4 - Enhance the ability of Deschutes County's economy to rebound quickly from the effects of natural hazard events.

Goal 5 - Minimize project impacts to the environment and utilize natural solutions to protect people and property from natural hazards.

Goal 6 - Enhance the County's capability to implement a comprehensive County wide natural hazards mitigation strategy.

Goal 7 - Motivate the "whole community" to build resilience and mitigate against the effects of natural hazards through engagement, listening, learning, information- sharing, and funding opportunities.

Goal 8 - Eliminate development within mapped hazardous areas where the risks to people and property cannot be practicably mitigated.

Goal 9 - Minimize damage to historic and cultural resources from natural hazards.

Goal 10 - Enhance communication, collaboration, and coordination among agencies at all levels of government, sovereign tribal nations, and the private sector to mitigate natural hazards.

Goal 11 - Mitigate the inequitable impacts of natural hazards by prioritizing and directing resources and investments to build resilience in the most vulnerable populations and the communities least able to respond and recover.

Goal 12 - Develop, integrate, and align natural hazards mitigation and climate adaptation efforts based on the evolving understanding of the interrelationships between climate change and climate-related natural hazard events.

Goal 13 - Reduce repetitive and severe repetitive flood losses.

Goal 14 - Minimize or eliminate potential impacts from dams posing the greatest risk to people, property, and infrastructure.

(Note: although numbered the goals are not prioritized.)

Mitigation Plan Action Items

Short- and long-term action items identified through the planning process are an important part of the mitigation plan. Action items are detailed recommendations for activities that local departments, citizens and others could engage in to reduce risk. They address both multi-hazard (MH) and hazard-specific issues. Action items can be developed through a number of sources such as steering committee work sessions, stakeholder input, etc. The figure below illustrates some of these sources. A description of how the plan's mitigation actions were developed is provided below.

Action Item Worksheets

Each action item has a corresponding action item worksheet describing the activity, identifying the rationale for the project, identifying potential ideas for implementation, and assigning coordinating and partner organizations. The action item worksheets can assist the community in pre-packaging potential projects for grant funding. The worksheet components are described within Volume I, Section 3 (Mitigation Strategy). The City specific action item worksheets are located in Attachment 1, *Action Item Forms*.

The City is also a party to several actions described in the County NHMP; each jurisdiction listed on the County Action Item forms as an “Affected Jurisdiction” will contribute to and work towards completion of that action as it pertains to their jurisdiction. There are 23 County Action Items that include La Pine as an “Affected Jurisdiction”. For detailed information on each County level action item form see Volume I, Section 3, *Mitigation Strategy* and Volume IV, Appendix A, *Action Item Forms*.

Action Item Development Process

Development of action items was a multi-step, iterative process that involved brainstorming, discussion, review, and revisions by the steering committee. A number of actions identified by the County steering committee include the City as an affected jurisdiction; these actions are broad actions that include implementation components at both the County and city level. All actions were reviewed by the committee and revised as necessary before becoming a part of this document.

ATTACHMENT I: ACTION ITEM FORMS

Action Item Forms

The action item forms portray the overall action plan framework and identify linkages between the plan goals, partnerships (coordination and partner organizations), and actions. Table LA-8 provides a list of actions for the city. The pages that follow include individual forms for each mitigation action.

Table LA-8 Mitigation Actions

Action Item	High Priority	Timeline	Status	Related Hazards								
				Drought	Earthquake	Flood	Landslide	Volcano	Wildfire	Windstorm	Winter Storm	
MH #1		Long-Term	Ongoing							X	X	X
MH #2	X	Short-Term	Removed	X		X						
MH #3	X	Short-Term	Removed	X		X						
DR #1	X	Long-Term	Ongoing	X								
FL #1		Long-Term	Complete			X						
WF #1	X	Ongoing	Removed							X		
New WF #2	X	Ongoing	New							X		

Source: City of La Pine NHMP Steering Committee

Mitigation Action: Multi-Hazard #1 (Previously "Winter Storm #1")		Alignment with Plan Goals:	High Priority Action Item?
Support local electric cooperative and seek funding to protect highest risk utility lines. Harden key infrastructure.		<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input checked="" type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Alignment with Existing Plans/Policies:			
Rationale for Proposal (Why is this important?):			
The La Pine area can experience large amounts of snowfall, which can place heavy loads on exposed utility infrastructure.			
Ideas for Implementation (How will it get done?):		Action Status Report	
Identify high-risk lines first and coordinate with local electric companies to bring attention to the need for hardening.		Ongoing (added in 2015). New transmissions have been built with fire resiliency codes in mind.	
Champion/ Responsible Organization:	City Administration and Public Works		
Internal Partners:		External Partners:	
Planning Department		Deschutes County , MidState Electric Cooperative	
Potential Funding Sources:		Estimated cost:	Timeline:
State, SDCs, levies, LIDs, grants, etc.		TBD	<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)
Form Submitted by:	2015 NHMP Committee		
Action Item Status:	Ongoing		

Mitigation Action: Multi-hazard #2 (What do we want to do?)		Alignment with Plan Goals:			High Priority Action Item?	
Explore options to create a cluster sewer system for La Pine and the area of the County between La Pine and Sunriver.		<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
La Pine Wastewater, Deschutes County, and DEQ plans						
Rationale for Proposal (Why is this important?):						
The underground geological formations in and near La Pine contain areas that do not support long-term septic use. This can pollute groundwater and has the potential to create safety hazards.						
Ideas for Implementation (How will it get done?):			Action Status Report			
The City, County, and DEQ will need to collaborate and define a study to resolve this issue.			Removed (added in 2015). The City will no longer be pursuing a cluster sewer system for La Pine and the area of County between La Pine and Sunriver.			
Champion/ Responsible Organization:		City Administration, Public Works				
Internal Partners:			External Partners:			
Planning Department, Finance, Legal			DEQ, Deschutes County			
Potential Funding Sources:		Estimated cost:		Timeline:		
State of Oregon, Deschutes County		\$10-15 million		<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Removed				

Mitigation Action: Multi-hazard #3 (What do we want to do?)		Alignment with Plan Goals:			High Priority Action Item?	
Improve existing sewer effluent leach field to mitigate concerns due to high groundwater.		<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input checked="" type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
La Pine Waste Water System Capital Facilities Plan, January 2006						
Rationale for Proposal (Why is this important?):						
The underground geological formations in and near La Pine contain areas that do not support long-term septic use. This can pollute groundwater and has the potential to create safety hazards.						
Ideas for Implementation (How will it get done?):			Action Status Report			
The City, County, and DEQ will need to collaborate and define a study to resolve this issue.			Removed (added in 2015). This action item does not have application to our current system as the City uses facultative lagoons onsite.			
Champion/ Responsible Organization:		City Administration and Public Works				
Internal Partners:			External Partners:			
Planning Department			Deschutes County and DEQ			
Potential Funding Sources:		Estimated cost:		Timeline:		
SDCs, levies, LIDs, grants, etc.		TBD		<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:	2015 NHMP Committee					
Action Item Status:	Removed					

Mitigation Action: Drought #1 (What do we want to do?)		Alignment with Plan Goals:			High Priority Action Item?	
Improve water supply and delivery systems to reduce vulnerability by acquiring additional water rights and providing a second water line from the city's reservoir, wells, and pumps. Improvements should be designed to accommodate drought events.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input checked="" type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
Water System Capital Facilities Plan (2016; currently being updated)						
Rationale for Proposal (Why is this important?):						
<p>There is one main line serving the city that is potentially vulnerable to natural hazards.</p> <p>The community is expected to grow and will need additional capacity to accommodate expected growth; additional systems should be developed to accommodate drought events.</p> <p>The Water System Capital Facilities Plan identifies additional water rights in the short-term of 0.67 cfs, and up to 2.032 cfs in the long-term to accommodate expected growth to operate both wells.</p>						
Ideas for Implementation (How will it get done?):			Action Status Report			
Master Plan updates will be scheduled and commensurate financing options clarified and implemented. This may include SDCs, levies, Local Improvement District bonding, grants, and other financing elements available to the city.			Ongoing (added in 2015). The Water System Plan was updated in 2016; La Pine has no potable secondary source due to mitigation questions.			
Champion/ Responsible Organization:		City Administration and Public Works: Contract Legal services				
Internal Partners:			External Partners:			
Planning Department, Finance Department			OWRD, DEQ, EPA, Deschutes County			
Potential Funding Sources:		Estimated cost:		Timeline:		
SDCs, levies, LIDs, grants, etc.		5,000,000.00		<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Flood #1 (What do we want to do?)		Alignment with Plan Goals:			High Priority Action Item?	
Identify drainage areas to provide better stormwater drainage in the core area due to rain or snow events.		<input type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input checked="" type="checkbox"/> 8	
		<input checked="" type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
Central Oregon Stormwater Manual, La Pine Code of Ordinances						
Rationale for Proposal (Why is this important?):						
By deliberately planning for stormwater management through improved drainage strategies, low impact development and green infrastructure, areas susceptible to drainage issues can be improved for reduced risk of flooding. These strategies could also be utilized to beautify areas with rain gardens, bioswales, etc.						
Ideas for Implementation (How will it get done?):			Action Status Report			
Closer coordination with developers in the design of onsite stormwater facilities. Identification of “problem areas” to focus resources for improvement; these areas could be used as demonstration/education sites for the public and developers.			Complete (added in 2015). In 2018-19: <ol style="list-style-type: none"> 1. The City installed a stormwater extension line along third street that travels east from Hwy. 97 and through the downtown core. This removes excess stormwater effluent, with a disbursement area located in the meadows west of the downtown core which mitigates both rain and snowmelt stormwater accumulation events. 2. The City, in concert with ODOT completed the HWY. 97 west side improvement project which included drywell installation and stormwater conveyance off of Hwy 97 which travels through the core of La Pine’s commercial district. 3. The City created on site retention for snowmelt in the downtown core with the creation of the pond/swale at the vacant 4th. St. & Hwy. 97 property. This retention pond is used in winter months for the containment of snow removal in the downtown area, and will facilitate clearing of future accumulation events as the City implements its Transit Center project on the property. 			
Responsible Organization:		City Administration and Public Works				
Internal Partners:			External Partners:			
Planning Department			Deschutes County and DEQ			
Potential Funding Sources:		Estimated cost:		Timeline:		
SDCs, levies, LIDs, grants, etc.		TBD		<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)		
Form Submitted by:		2015 NHMP Committee				

Action Item Status:	Complete			
Mitigation Action: Wildfire #1 (What do we want to do?)	Alignment with Plan Goals:		High Priority Action Item?	
Support projects to reduce fuel inside and adjacent to city to provide buffer zones around populated areas.	<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4
	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8
	<input checked="" type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11	<input checked="" type="checkbox"/> Yes
Alignment with Existing Plans/Policies:				
La Pine Code of Ordinances				
Rationale for Proposal (Why is this important?):				
Wildfire has proven to be a significant natural hazard in Central Oregon, with thousands of acres burned every year. To minimize the risk of La Pine, its residents, and its structures from being impacted by a wildfire, fire fuels must be minimized to slow the spread of potential fires.				
Ideas for Implementation (How will it get done?):		Action Status Report		
Coordinate with County to continue thinning forests on the periphery of town. Code enforcement for overgrown properties.		Removed (added in 2015). This action item was removed and revised to more accurately reflect the ongoing mitigation work related to wildland fire prevention in the City of La Pine. See NEW Wildfire #1 for the revised action item.		
Champion/ Responsible Organization:	City Administration, Public Works, Fire Department			
Internal Partners:		External Partners:		
Planning Department		Deschutes County		
Potential Funding Sources:		Estimated cost:	Timeline:	
Local funding resources, Project Wildfire, ODF		TBD	<input checked="" type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:	2015 NHMP Committee			
Action Item Status:	Removed			

Mitigation Action: NEW Wildfire #2 (What do we want to do?)		Alignment with Plan Goals:	High Priority Action Item?
Support projects to reduce fuel inside and adjacent to city in wildland-urban interface areas by: a. Improving forest health & resiliency b. Hardening communities and structures c. Fire prevention d. Suppression support		<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input checked="" type="checkbox"/> 7 <input type="checkbox"/> 8 <input checked="" type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14	<input checked="" type="checkbox"/> Yes
Alignment with Existing Plans/Policies:			
La Pine Code of Ordinances, Greater La Pine CWPP, Central Oregon Cohesive Strategy			
Rationale for Proposal (Why is this important?):			
Wildfire has proven to be a significant natural hazard in Central Oregon, with thousands of acres burned every year. To minimize the risks to La Pine, its residents, and its structures from the impacts of a wildfire, fire fuels must be minimized to slow the spread of potential fires.			
Ideas for Implementation (How will it get done?):		Action Status Report:	
1. Thinning, Prescribed Burns 2. Adopting wildfire building codes; Zoning - Adequate building separations; Maintaining private properties per WUI SB 360 Oregon Community Wildfire Protection Act of 1997 3. Community burn regulations; Fireworks ban – sales and private use; Underground utilities 4. City Water supply – Fire Hydrants		Added in 2021.	
Champion/ Responsible Organization:		City Administration, Public Works, Fire Department	
Internal Partners:		External Partners:	
Planning Department		Deschutes County, USFS/BLM, ODF, City of La Pine	
Potential Funding Sources:		Estimated cost:	Timeline:
Local funding resources, Project Wildfire, ODF, USFS, FEMA, NRCS		High – More than \$100,000	<input checked="" type="checkbox"/> Ongoing <input type="checkbox"/> Long-Term (3-5 years) <input type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short Term (1-2 years)
Form Submitted by:	2021 NHMP Committee		
Action Item Status:	New		

ATTACHMENT 2: ACTION ITEM FORM TEMPLATE

Action Item: (What do we want to do?)	Alignment with Plan Goals:	High Priority Action Item?
	1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input type="checkbox"/> Yes
Alignment with Existing Plans/Policies:		
Rationale for Proposed Action Item (why is it important?):		
Ideas for Implementation (how will it get done?):	Action Status Report	
Potential Funding Sources:	Estimated Cost:	Timeline:
		<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)
Coordinating/Lead Organization:		
Internal Partners:	External Partners:	
Form Submitted by:		
Action Item Status		

CITY OF REDMOND ADDENDUM

Introduction

This document serves as the City of Redmond's Addendum to the Deschutes County Natural Hazards Mitigation Plan (NHMP). The City's Addendum is considered part of the County's multi-jurisdictional plan, and meets the following requirements: (1) Multi-jurisdictional Plan Adoption §201.6(c)(5), (2) Multi-jurisdictional Participation §201.6(a)(3), (3) Multi-Jurisdictional Risk Assessment §201.6(c)(2) (iii), and (4) Multi-jurisdictional Mitigation Strategy §201.6(c)(3) (iv).

A description of the city specific planning and adoption process follows, along with detailed community specific action items; for detailed information see Volume IV, Appendix B. Information about the city's risk relative to the County's risk to natural hazards is documented in this addendum's Hazard Analysis and Issue Identification section. The section considers how the city's risk differs from or matches that of the County's; additional information on the Risk Assessment is provided within Volume I, Section 2 of this NHMP. The community's mitigation strategy is provided herein along with community specific action items; action items that have a city role but are identified at the County level are provided in Volume I, Section 3 and Volume IV, Appendix A.

How was the Plan Developed?

The NHMP was developed by the Deschutes County Natural Hazard Mitigation Plan steering committee, while this addendum was created by the City of Redmond steering committee. The Deschutes County Emergency Manager was designated as the NHMP's convener and will take the lead in implementing, maintaining and updating the plan. Locally, the City of Redmond convened a steering committee for the purpose of developing the city's addendum.

The local steering committee was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. The local steering committee met on one occasion: April 16th, 2021 (see Appendix B for more information). Steering committee members contributed data and reviewed, and provided guidance towards the community profile, risk assessment, mitigation strategy (action items), and implementation and maintenance plan. The addendum reflects effort from the formal meeting and during subsequent informal meetings between members of the steering committee and with Central Oregon Intergovernmental Council (COIC).

An open public involvement process is essential to the development of an effective plan. In order to develop a comprehensive approach to reducing the effects of natural disasters, the planning process should include opportunities for the public, neighboring communities, local and regional agencies, as well as private and nonprofit entities to comment on the plan.¹ COIC provided a publicly accessible project webpage for the general public in order to make meeting materials and contact information available throughout the update process. In addition,

¹ Code of Federal Regulations, Chapter 44. Section 201.6, subsection (b). 2015

Deschutes County and the City of Redmond provided press releases on their websites to encourage the public to offer feedback on the plan update.

In addition, COIC administered a public opinion survey to obtain additional input from the public regarding the county’s risks, vulnerabilities, hazards history, and mitigation strategies. See Volume IV, Appendix F for more information.

Updating the mitigation plan is a requirement to gain eligibility for the Federal Emergency Management Agency’s Pre-Disaster Mitigation, Hazard Mitigation, and Flood Mitigation Assistance grant Programs. This project is funded through the Federal Emergency Management Agency’s (FEMA) FY12 Pre-Disaster Mitigation Competitive Grant Program (PDMC – PL-10-OR-2012-002).

The Redmond Addendum to the Deschutes County NHMP was adopted on November 16, 2021 and approved by FEMA on October 28, 2021. The Deschutes MNHMP was approved by FEMA on October 28, 2021, the plan is effective for Deschutes County and Redmond through October 27, 2026.

For more information on the composition of the steering committee and the process see this NHMP’s Volume I, Acknowledgements and Executive Summary, and Volume IV, Appendix B.

Action Item Matrix

The City’s action items were first developed through a two-stage process in 2015 by the local steering committee, facilitated by Oregon Partnership for Disaster Resilience (OPDR). In 2021, the local steering committee, facilitated by COIC, updated the status of existing action items and removed one action item. In addition, there are 18 County Action Items that include Redmond as an “Affected Jurisdiction.” For additional information see the discussion near the end of this document.

The City’s actions are listed below in matrix format. For more detailed information on each action, see the action forms within Attachment 1 of this addendum. For additional information on the County actions affecting the city see Volume I, Section 3 and Volume IV, Appendix A.

Table RA-1 City of Redmond Action Items

2021 Action Item	High Priority	Mitigation Action Title	Lead Organization	Partner Organization(s)	Timeline	Status
Multihazard #1	X	Participate in emergency preparedness and disaster planning with the County, Redmond School District and other organizations to ready the City and Citizens for emergency situations.	Community Development	Internal: Police Department, Public Works, Redmond Airport External: Deschutes County Emergency Services, Redmond F & R	Long-Term	Ongoing
Earthquake #1		Examine the airport facility needs related to emergency preparedness and its regional designation in the Oregon Resiliency Plan and the Cascadia Event.	Redmond Airport	Internal: Community Development, Engineering, Public Works External: Deschutes County Community Development, Emergency Services	Ongoing	Ongoing
Flood #1		Complete a stormwater drainage study and mitigate problem areas.	Public Works	Internal: Community Development External: OWRD	Long-Term	Removed

Source: City of Redmond NHMP Steering Committee, 2021

How Will the Plan be Implemented?

The City Council will be responsible for adopting the City of Redmond addendum to the Deschutes County NHMP. This addendum designates a coordinating body and a convener to oversee the development and implementation of action items. Because the city addendum is considered part of the County plan, the city will look for opportunities to partner with the County to maintain the plan, and coordinate mitigation efforts through the implementation of action items, etc. The City’s steering committee will convene after re-adoption of the City of Sisters addendum annually with the County every fall. For more details on the meeting schedule and process, see Volume I, Section 4. The City’s Planning Manager and Public Works Director will serve as the co-conveners and will be responsible for convening the local steering committee. The convener will also remain active in the County’s planning process. The steering committee will seek to involve senior staff and decision makers throughout the duration of the five-year implementation and maintenance of the NHMP addendum.

Implementation through Existing Programs

Many of the Natural Hazards Mitigation Plan’s recommendations are consistent with the goals and objectives of the city’s existing plans and policies. Where possible, the City of Redmond will implement the NHMP’s recommended actions through existing plans and policies. Plans and policies already in existence have support from local residents, businesses, and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, allowing them to adapt to changing conditions and needs. Implementing the NHMP’s action items through such plans and policies increases their likelihood of being supported and implemented.

The City of Redmond currently has the following plans that relate to natural hazard mitigation:

Table RA-2 Existing Plans

Jurisdiction	Document	Year
City of Redmond	Comprehensive Plan and supporting materials	2020
City of Redmond	Development Code (no mapped SFHA)*	2015
City of Redmond	Transportation Master Plan	2020
City of Redmond	Greater Redmond CWPP**	2017
City of Redmond	Wastewater Collection System	2007
City of Redmond	Wastewater Facility Plan: Redmond Water Pollution Control Facility*	2021
City of Redmond	Wastewater Facility Plan: Redmond Water System*	2021
City of Redmond	Water System Risk & Resilience Plan	2021
Redmond Municipal Airport	Airport Master Plan	2019

Source: City of Redmond | *Revision in process | **Up for revision in 2021-2022

The steering committee and the community’s leadership have the option to add or implement action items at any time. This allows the steering committee to consider mitigation strategies as new opportunities arise, such as funding for action items that may not be of the highest priority. When new actions are identified, they should be documented using an action item form (see Attachment 2). Once a proposed action form has been submitted to the convener, the action will become part of the City’s addendum.

Continued Public Participation

Keeping the public informed of the city's efforts to reduce the city's risk to future natural hazards events is important for successful plan implementation and maintenance. The city is committed to involving the public in the plan review and updated process. The City Addendum along with the County Plan will be posted online on COIC's website (<https://www.coic.org/emergency-preparedness/natural-hazard-mitigation-plans/deschutes-county-nhmp/>), as well as the County and City websites, so that the public may view the plan at any time.

In addition, natural hazards information dissemination is conducted throughout the year when opportunities present themselves via the city offices and website.

Plan Maintenance

The multi-jurisdictional Deschutes County Natural Hazards Mitigation Plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the County plan update process, the city will also review and update its addendum. The convener will be responsible for convening the steering committee to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help the steering committee determine what components of the mitigation plan need updating. The steering committee will be responsible for updating any deficiencies found in the plan.

The remainder of this addendum includes three sections:

1. Community Profile and Asset Identification,
2. Hazard Identification and Risk Assessment, and
3. Mitigation Strategy.

COMMUNITY PROFILE ASSET IDENTIFICATION

This section provides city specific asset identification. For information on the characteristics of Redmond, in terms of geography, environment, population, demographics, employment and economics, as well as housing and transportation see Volume IV, Appendix C, *Community Profile*. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

We live in a place with a varied geography and communities. We would like to recognize and acknowledge the indigenous land of the Confederated Tribes of Warm Springs, Molalla, Paiute, Klamath, Modok, Yahooskin Band of Snake Indians, and Tribes of Middle Oregon. We want to recognize the people that came before us and honor their traditions and stewardship of the land. Acknowledgement is a simple, powerful way of showing respect for Indigenous People's history and culture.

Asset Identification

The following assets were identified by the steering committee in 2015 and updated in 2021:

Critical and Essential Facilities

- Deschutes County Sheriff's Office Emergency Management has access to an inventory of critical and essential facilities.

Special Districts with Offices in Redmond

- Central Electric Cooperative – 2098 N Highway 97
- Pacific Power – 1440 SE Lake Road
- Redmond Fire & Rescue
 - Station 401 Headquarters – 341 NW Dogwood
 - Station 403 Airport – 911 SE Salmon
 - Station 404 Cline Falls – 100 SE 67th Street

Redmond School District (schools located in Redmond)

Elementary Schools:

- John Tuck – 209 NW 10th Street
- MA Lynch – 1314 SW Kalama Street
- Sage – 2790 SW Wickiup Ave
- Tom McCall – 1200 NW Upas
- Vern Patrick – 3001 SW Obsidian

Middle Schools:

- Elton Gregory – 1220 NW Upas
- Obsidian – 1334 SE Obsidian Drive

High Schools:

- Edwin Brown Education Center - 850 W Antler Avenue
- Redmond – 675 SW Rimrock Drive
- Redmond Proficiency Academy
 - 657 SW Glacier Ste 2370
 - RPA Middle SW 25th St
- Downtown - 657 Glacier Avenue
- West Campus - 2105 W Antler Avenue
- Ridgeview – 4555 SW Elkhorn Avenue

Colleges and Universities

- Central Oregon Community College – 2030 SE College Loop

Hospitals

- St. Charles Medical Center – 1253 NW Canal Boulevard

Social Service Providers

Please see <https://www.thrivecentraloregon.org/services> for a comprehensive list of resource providers throughout Central Oregon, including Sisters.

Population

Redmond’s certified population estimate as of July 1, 2020 was 32,215 people². Redmond has become a mid-sized community of over 30,000 and has grown by 6,000 residents since the 2010 Census. By the year 2032, Redmond’s population is expected to grow to over 40,000 residents and to 51,625 by 2043³. This represents an increase of almost 20,000 people in the next 20 years or approximately 1,000 new residents per year.

Land Use

The City acknowledged comprehensive plan is the “Redmond Comprehensive Plan 2040”. The Oregon Land Conservation and Development Commission first acknowledged the comprehensive plan in 1979. The City completed a major update to the comprehensive plan in December of 2020.

² Portland State University Population Research Center.

³ Coordinate Population Forecast 2018 - 2068; Deschutes County Urban Growth Boundaries & Areas Outside UGBs - Population Research Center Portland State University

The City implements the plan through: 1) 2040 Greater Redmond Area Comprehensive Plan and Zone Map, 2) creating alignment with the 33 Support Plans identified in the Comprehensive Plan 2040, and 3) Redmond Development Code (Chapter 8 of the City Code).

The Redmond Comprehensive Plan 2040 is a policy framework rooted in a factual basis that helps inform other critical planning documents and implementing tools that together serve as a coordinated, overarching strategy for the City. This approach established the structure for how the City functions and the types of services that it provides. Ultimately, the Comprehensive Plan outlines the direction that the City will take when planning for land use and making public investments.

Redmond has been chosen as a pilot community by the Department of Land Conservation and Development to enact the process that is provided in Oregon Administrative Rules 660-024-0045 to preserve large industrial lots for regional large-lot industrial needs. The area chosen for this is just south of the current Redmond UGB and south of the Deschutes County Fairgrounds. On May 7, 2015, the Central Oregon Intergovernmental Council unanimously voted to endorse the South Redmond Tract as the first site in the Regional Large Lot Industrial program. With this endorsement, the property owner, Department of State Lands, will start a UGB amendment process and request annexation into the city limits and rezoning to the Large Lot Industrial described in the Oregon Administrative Rules (OARs) above. The site is about 1,000 acres and has been successfully added to the UGB.

Redmond Parks and Recreation

City of Redmond

The City of Redmond Parks Division maintains over 26 public parks and their facilities, which includes picnic areas, trails and playgrounds. Biking, fishing and skateboarding are just some of the many activities available in Redmond's parks.

Redmond Area Park and Recreation District – RAPRD

At this time, the district's facilities include the Cascade Swim Center and CSC Park, the RAPRD Activity Center, the High Desert Sports Complex, and undeveloped parks at Majestic Ridge in Redmond and outside the city limits at Tetherow Crossing and Borden Beck Park. RAPRD offers recreational programs for the greater Redmond, Oregon community. The district offers a variety of recreation programs. These include youth and adult sports, before and after school programs, Red Cross classes, art classes, swim lessons and many others.

Economy

Redmond is one of the fastest growing cities in Deschutes County. The community has a fast growing manufacturing sector (growing 22% in employment from 2012-2015)⁴. The growing traded sector industries in Redmond include⁵:

- Bioscience;
- Aviation and Aerospace Manufacturing;

⁴ Economic Development for Central Oregon website, <https://www.edcinfo.com/>, accessed April 28, 2015.

⁵ Ibid

- Specialty manufacturing;
- Building Products Manufacturing;
- Corporate and Administrative Office Centers; and
- Food Manufacturing.

The seasonally adjusted unemployment rate for Deschutes County was 8.6% in 2020. The city adopted its first comprehensive Economics Opportunity Analysis (EOA) in 2020. The EOA included various economic policies which were incorporated into the 2040 Comprehensive Plan. Redmond works closely with Redmond Economic Development Inc. (REDI).

Cultural and Historic Resources

The sites and structures listed below (Table RA-3) represent the city’s official list of historic places compiled by the city and County, and approved by the Oregon Land Conservation and Development Commission.⁶

Table RA-3 List of Historic and Cultural Resources - City of Redmond

Historic Site/ Name	Location
Jack Elliot House	303 NW Canyon Dr.
Redmond Passenger Depot	3716 SW 21st Place
Redmond Freight Depot	778 NE 11th St
Robert (Roy) Holmes House	349 SW 12th St
J. Sidney and Lizzie Lloyed House	135 SW 6th St
John Roberts House	111 NW 8th St
East Whited Farmstead	2087 SW Helmholtz
Fred Atkinson Building	535-537 S. 6th St.
J.D. Butler Building	453 S. 6th St.
Theron Beogher Cottage	422 S.W. 13th St.
Presbyterian Community Church	641 S.W. Cascade Ave.
Ehret Brothers Store	251 S. 6th St.
B.H. & A.T. McMickle House	614 N.W. Cedar Ave.
Milton Odem House	623 S.W. 12th St.
Redmond Union High School	411 S.W. 9th St.
Lew A. Smith House	1329 S.W. Evergreen
The New Redmond Hotel	521 S. 6th St.
WWII Airport Hanger	Sisters Avenue
Roy Carpenter House	342 S.W. Canyon Dr.
C.O. Cooperative Creamery	640 S.W. Evergreen Ave.

Source: City of Redmond

⁶ Redmond Area General Plan, 1998.

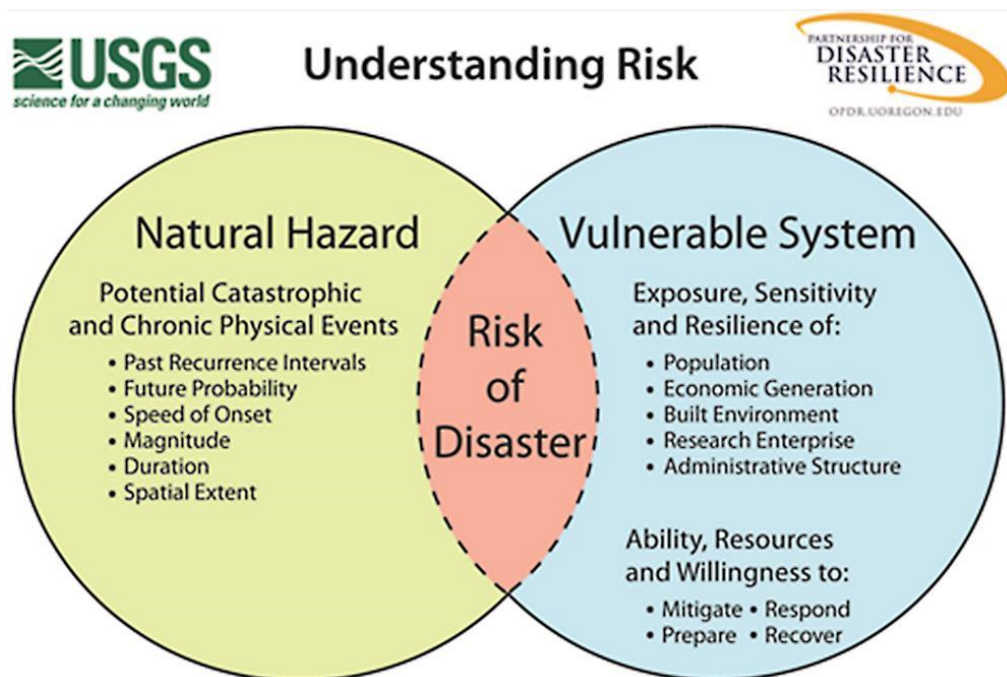
RISK ASSESSMENT

This section of the NHMP addendum addresses 44 CFR 201.6(b)(2) - Risk Assessment. In addition, this chapter can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – Areas Subject to Natural Hazards. Assessing natural hazard risk has three phases:

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

The information presented below, along with hazard specific information presented elsewhere in this addendum, within the Hazard Annexes (Volume II), and community characteristics presented in the Community Profile (Appendix C), will be used as the local level rationale for the risk reduction actions identified in this addendum. The risk assessment process is graphically depicted in Figure RA-1 below. Ultimately, the goal of hazard mitigation is to reduce the area where hazards overlap vulnerable systems.

Figure RA-1 Understanding Risk



Source: Oregon Partnership for Disaster Resilience

Hazard Analysis Methodology

This NHMP utilizes a hazard analysis methodology that was first developed by FEMA circa 1983, and gradually refined by the Oregon Military Department’s Office 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%.

This 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 shown in the table below. See Volume I, Section 2 (Risk Assessment) for more information.

Hazard Analysis

On April 16th, 2021, the City of Redmond addendum steering committee developed their hazard vulnerability assessment (HVA), using the County’s HVA as a reference. Changes from the County’s HVA were made where appropriate to reflect distinctions in vulnerability and risk from natural hazards unique to the City of Redmond, which are discussed throughout this addendum.

Table RA-4 shows the HVA matrix for Redmond showing each hazard listed in order of rank from high to low. For local governments, conducting the hazard analysis is a useful step in planning for hazard mitigation, response, and recovery. The method provides the jurisdiction with a sense of hazard priorities, but does not predict the occurrence of a particular hazard.

Table RA-4 Hazard Analysis Matrix – City of Redmond

Hazard	History	Probability	Vulnerability	Maximum Threat	Total Threat Score	Hazard Rank	
Winter Storm	20	70	50	90	230	# 1	
Wildfire	10	49	45	90	194	# 2	Top Tier
Windstorm	16	63	20	80	179	# 3	
Volcano	2	14	50	100	166	# 4	
Earthquake (Cascadia)	2	7	40	100	149	# 5	
Drought	8	56	15	30	109	# 6	Middle Tier
Earthquake (Crustal)	2	14	5	80	101	# 7	
Flood	2	7	5	10	24	# 8	
Landslide	2	7	5	10	24	# 8	Bottom Tier

Source: City of Redmond NHMP Steering Committee, 2021.

Three chronic hazards (winter storm, wildfire and windstorm) and one catastrophic hazard (volcano) rank as the top four hazard threats to the city (Top Tier). The Cascadia earthquake,

drought, and crustal earthquake hazards comprise the next three highest ranked hazards (Middle Tier), while flood and landslide hazards comprise the lowest ranked hazards (Bottom Tier).

Table RA-5 categorizes the probability and vulnerability scores from the hazard analysis for the city and compares the results to the assessment completed by the Deschutes County NHMP Steering Committee (areas of difference are noted with **bold** text within the city ratings).

Table RA-5 Probability and Vulnerability Comparison

Hazard	Redmond		County	
	Probability	Vulnerability	Probability	Vulnerability
Drought	High	Low	High	Low
Earthquake (Cascadia)	Low	High	Low	High
Earthquake (Crustal)	Low	Moderate	Low	Low
Flood	Low	Low	High	Low
Landslide	Low	Low	Moderate	Low
Volcano	Low	High	Low	High
Wildfire	Moderate	High	High	High
Windstorm	High	Moderate	High	High
Winter Storm	High	High	High	High

Source: City of Redmond NHMP Steering Committee and Deschutes County NHMP Steering Committee, 2021.

Drought

A drought is a period of drier than normal conditions that results in water-related problems. 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.

The steering committee determined that the city’s probability for drought is **high** (which is the same as the County’s rating) and that their vulnerability to drought is **low** (which is the same as the County’s rating).

The city has ample high quality groundwater supplies fed by seven (7) production wells within the Deschutes regional aquifer. There are no issues with groundwater supply and the annual recharge to the aquifer is high and long-term water level trends show ample supply for expected population growth and water usage.⁷ In addition, the city maintains six (6) storage facilities totaling 13.5 million gallons, two (2) booster pump stations, one (1) transfer pump station, and one (1) pressure reducing station.⁸

For more information on the Drought Hazard (including history and extent) see the Drought Annex in Volume II.

⁷ CH2MHill, 2007. Wastewater (collection system) and Water System Master Plan. City of Redmond Oregon.

⁸ City of Redmond Website, <http://www.redmond.or.us/>, accessed April 16, 2021.

Earthquake

Oregon and the Pacific Northwest in general are susceptible to earthquakes from four sources: 1) the off-shore Cascadia Fault 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.⁹

The areas most susceptible to ground amplification and liquefaction have young, soft alluvial sediments, found along river and stream channels. The extent of the damage to structures and injury and death to people will depend upon the type of earthquake, proximity to the epicenter and the magnitude and duration of the event.

The steering committee HVA evaluated both crustal earthquakes and a Cascadia earthquake. The steering committee determined that the city's probability of experiencing a crustal earthquake is **low** (which is the same as the County's rating) and that their vulnerability to a crustal earthquake is **low** (which is lower than the County's rating). The steering committee determined that the city's probability of experiencing a Cascadia earthquake is **low** (which is the same as the County's rating) and that their vulnerability to a Cascadia earthquake is **high** (which is the same as the County's rating).

Two-thirds of Redmond's buildings were built after 1990 and the codification of seismic codes. Redmond is not particularly susceptible to liquefaction, and is not expected to experience very strong to violent shaking in an earthquake event (see Volume II, Tables II-5 and II-6). As such, the city's vulnerability to earthquakes is reduced because of its relatively new infrastructure and buildings in combination with the particular geology of the area. However, the city considers itself to have high vulnerability to a Cascadia earthquake event due to secondary effects of the hazard, including access to transportation routes, energy resources, communications, and the need to assist with refugees of the damage that is expected west of the Cascades.

Information on specific buildings' estimated seismic resistance, determined by DOGAMI in 2007, is shown in Tables RA-6 below. The table displays the rankings of all facilities within the city's jurisdiction; each "X" represents one building within that ranking category. These scores have not been updated since 2007, but any new buildings can be assumed "low" risk given new building codes.

Of the school facilities evaluated by DOGAMI using RVS, none have very high (100% chance) collapse potential. Five (5) buildings have high (greater than 10% chance) collapse potential; however, three of these buildings are located at the former Evergreen Elementary School which is no longer used as a school facility (it is expected that these buildings will receive structural seismic upgrades and be the future home of city hall). Of the public safety facilities evaluated, none have very high (100% chance) collapse potential; however, two (2) buildings have high (greater than 10% chance) collapse potential. None of the community college buildings or the hospital are rated with High or Very High collapse potentials.

⁹ Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. 1999

Table RA-6 Rapid Visual Survey Scores

Facility	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Schools				
John Tuck Elementary School (209 NW 10th St, Redmond)	X	XXXX		
MA Lynch Elementary School (1314 SW Kalama St, Redmond)		XX		
Vern Patrick Elementary School (3001 SW Obsidian, Redmond)	X			
**Deschutes Edge Charter School (1220 NW Upas, Redmond)			X	
Hugh Hartman Middle School (2105 W Antler, Redmond)	X			
Obsidian Middle School (1334 SE Obsidian Ave, Redmond)			X	
Redmond High School (675 SW Rimrock Dr, Redmond)	X	XXX		
Ridgeview High School (4555 SW Elkhorn Ave, Redmond OR 97756)	Not addressed in the 2007 survey			
Central Oregon Community College - Redmond Campus				
College Center	X			
MATL	X			
One Stop Building	X			
Public Safety				
Redmond F&R - Station 401 Headquarters (341 NW Dogwood, Redmond)	X			
Redmond F&R - Station 403 Airport (911 SE Salmon, Redmond)			X	
Hospitals				
St. Charles Medical Center - Redmond (1253 NW Canal Blvd, Redmond)		XX		

Source: DOGAMI 2007. Open File Report 0-07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.

The County and cities have opted to create one action item for all the facilities that have a ‘high’ or ‘very high’ rating (see Appendix A). The buildings with ‘high’ or ‘very high’ collapse potential include multiple education and public safety facilities located throughout the city, all of which can play a key role in/during disaster events or during long-term recovery.

For more information on the Earthquake Hazard (including history and extent) see the Earthquake Annex in Volume II.

Flood

Flooding results when rain and snowmelt creates water flow that exceeds the carrying capacity of rivers, streams, channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall.

Most of Oregon’s destructive natural disasters have been floods.¹⁰ Flooding can be aggravated when rain is accompanied by snowmelt and frozen ground; the spring cycle of melting snow is the most common source of flood in the region. The principal types of flood that occur in Redmond include flash floods (associated with thunderstorms) that occur frequently and may cause localized flooding that can impact development within Redmond as it did in August 2013¹¹. Redmond is the only incorporated city within Deschutes County that does not have a mapped special flood hazard area (floodplain); the Deschutes River is located west of the city. However, the city does have a canal that runs through the city as part of the Central Oregon Irrigation District’s (COID) Pilot Butte Canal (running from Bend, through Redmond to Terrebonne).

The steering committee determined that the city’s probability for flood is **low** (which is lower than the County’s rating) and that their vulnerability to flood is **low** (which is the same as the County’s rating).

National Flood Insurance Program (NFIP)

The Deschutes County Flood Insurance Rate Maps (FIRMs) were modernized in 2007 and do not include a special flood hazard area for Redmond. The table below shows that as of November 2014, Redmond has zero (0) National Flood Insurance Program (NFIP) policies in force and no paid claims. The city has never had a Community Assistance Visit (CAV) and is not a member of the Community Rating System (CRS). The community repetitive flood loss record for Redmond does not include any repetitive flood loss, or severe repetitive flood loss, buildings and has not had any repetitive loss claims.

Table RA-7 Flood Insurance Detail

Jurisdiction	Current FIRM Date	Initial FIRM Date	Total Policies	Pre-FIRM Policies	Policies by Building Type				Minus Rated A Zone
					Single Family	2 to 4 Family	Other Residential	Non-Residential	
Redmond	9/28/2007	9/28/2007	0	0	0	0	0	0	0

Jurisdiction	Insurance In Force	Total Paid Claims	Pre-FIRM Claims Paid	Substantial Damage Claims	Repetitive Loss Buildings	Severe Repetitive Loss Buildings	Total Paid Amount	CRS Class Rating	Last CAV

Source: Information supplied by the Federal Emergency Management Agency, April 2021.
 NP - Not Participating | NA - Information not Available/ Not Applicable.

For more information on the Flood Hazard (including history and extent) see the Flood Annex in Volume II.

Landslide

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

¹⁰ Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. 1999
¹¹ “Redmond couple’s home hit by flooding” KTVZ News, accessed April 29, 2015, <http://www.ktvz.com/news/redmond-couples-home-hit-by-flooding/21678364>

materials that act to retard the movement and stabilize the slope. When the driving forces exceed the resisting forces, a landslide occurs.

The steering committee determined that the city's probability for landslide is **low** (which is lower than the County's rating) and that their vulnerability to landslide is **low** (which is the same as the County's rating).

The city has had no problems with landslides in city limits in known history and is located in a generally stable area. A few neighborhoods within the city (around the Dry Canyon) are located on steep hillsides but have not experienced problems in the past.

For more information on the Landslide Hazard (including history and extent) see the Landslide Annex in Volume II.

Volcano

The Pacific Northwest lies within the "ring of fire", an area of very active volcanic activity surrounding the Pacific Basin. Volcanic events occur regularly along the ring of fire, in part because of the movement of the Earth's tectonic plates. Volcanic events have the potential to coincide with numerous other hazards including ash fall, earthquakes, lava flows, pyroclastic flows, lahars, and debris flows, and landslides.

The steering committee determined that the city's probability for a volcanic event is **low** (which is the same as the County's rating) and that their vulnerability to a volcanic event is **high** (which is the same as the County's rating).

Were a volcanic event to occur in the Cascades region of Oregon, Redmond could be at risk for ash fall, depending on the severity of the event and the direction of the wind. Due to Redmond's proximity to the Three Sisters and Newberry Crater, in relation to other areas within eastern Oregon, the effects of a volcanic event may be more disruptive to normal business, economic activity, and health.

For more information on the Volcano Hazard (including history and extent) see the Volcano Annex in Volume II.

Wildfire

Wildfires occur in areas with large amounts of flammable vegetation that require a suppression response due to uncontrolled burning. Fire is an essential part of Oregon's ecosystem, but can also pose a serious threat to life and property particularly in the state's growing rural communities. Wildfire can be divided into three categories: interface, wildland, and firestorms. The increase in residential development in the Wildland Urban Interface areas has resulted in greater wildfire risk. Fire has historically been a natural wildland element and can sweep through vegetation that is adjacent to a combustible home. New residents in remote locations are often surprised to learn that in moving away from built-up urban areas, they have also left behind readily available fire services providing structural protection.

The steering committee determined that the city's probability for wildfire is **moderate** (which is lower than the County's rating) and that their vulnerability to wildfire is **high** (which is the same as the County's rating).

Compared to other areas within the County, Redmond has a lower risk of wildfire due, in part, to its location in relation to irrigated agricultural land. The Greater Redmond Area Community Wildfire Protection Plan (CWPP, October 2011) relies upon (1) the Oregon Department of Forestry Assessment of Risk Factors and (2) the classification ratings of individual areas under the Oregon Forestland-Urban Interface Fire Protection Act of 1997 (Senate Bill 360) to determine fire risk within the Greater Redmond Wildland-Urban Interface (WUI). According to the Senate Bill 360 ratings all Redmond WUI communities (see Attachment 3) are rated as High fire risk. According to the ODF Assessment all urban areas within the Greater Redmond WUI are rated with a Moderate probability of wildfire risk occurring (except for the urban southwest which is rated High) and Low vulnerability¹². The first priority areas for hazardous fuel treatments identified within the CWPP include the urban northwest community (the three other urban communities are listed as second priority).¹³ For more information on wildfire risk and fuels reduction projects see the Greater Redmond Area CWPP and visit the Project Wildfire website: <http://www.projectwildfire.org/>.

Table RA-8 Wildfire Communities and ODF and SB 360 Hazard Ratings

Community at Risk	Acreage	Homes	Estimated Population	ODF		SB 360	
				Probability	Vulnerability	High	Extreme
Northeast	13,797	815	2,038	Moderate	Low	97.9%	2.1%
Southeast	26,354	116	290	High	Low	100.0%	0.0%
Northwest	34,809	2,677	6,692	Moderate	Low	93.5%	6.5%
Southwest	20,388	2,437	6,092	High	Low	97.0%	3.0%
Urban Northeast	3,263	961	2,402	Moderate	Low	100.0%	0.0%
Urban Southeast	4,462	500	1,250	Moderate	Low	100.0%	0.0%
Urban Northwest	3,351	3,139	7,848	Moderate	Low	100.0%	0.0%
Urban Southwest	4,579	5,459	13,648	High	Low	100.0%	0.0%
Total	111,003	16,104	40,260	-	-	97.2%	2.8%

Source: Greater Redmond CWPP compiled Tables 1, 2, and 5

Note: Estimated population is based on Deschutes County's estimate formulated as 2.5 x the number of homes.

For more information on the Wildfire Hazard (including history and extent) see the Wildfire Annex in Volume II and the Greater Redmond CWPP.

Windstorm

Winds associated with thunderstorms are short-lived, but strong winds not associated with thunderstorms can last several hours. Although windstorms can affect the entirety of Deschutes 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.

¹² The ODF Assessment takes into account the likelihood of a fire occurring, hazard rating, protection capability, human and economic values protected, structural vulnerability to determine the overall score. For detailed information review the CWPP available on the Project Wildfire website: <http://www.projectwildfire.org/>

¹³ Greater Redmond CWPP, 2011.

The steering committee determined that the city's probability for windstorm is **high** (which is the same as the County's rating) and that their vulnerability to windstorm is **moderate** (which is lower than the County's rating).

Historical wind events have uprooted trees, damaged roofs and windows, and damaged utility lines. Windstorms have not caused disastrous local damage but are a persistent problem. Windstorms are often associated with microbursts (thunderstorms). A primary windstorm vulnerability for the community is damage to utility lines, including fiber optics, which are key to the economic sectors of the community.

For more information on the Windstorm Hazard (including history and extent) see the Windstorm Annex in Volume II.

Winter Storm

Severe winter storms can consist of rain, freezing rain, ice, snow, cold temperatures, and wind. They originate from troughs of low pressure offshore that ride along the jet stream during fall, winter, and early spring months. Severe winter storms affecting Deschutes County typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from November through March.

The steering committee determined that the city's probability for winter storm is **high** (which is the same as the County's rating) and that their vulnerability to winter storm is **high** (which is the same as the County's rating).

Redmond is located in the high desert of Central Oregon, on the east flanks of the Cascades. Positioned at this desert-mountain interface subjects the city to often intense and unpredictable storm events. Major winter storms can and have occurred in the Redmond area, and while they typically do not cause significant damage; they are frequent and have the potential to impact economic activity. Road closures on Highway 97, or the passes to the Willamette Valley (Highways 58 and 126), due to winter weather are a common occurrence and can interrupt commuter and large truck traffic. The city budgets funds for seasonal winter storm needs, such as clearing roads.

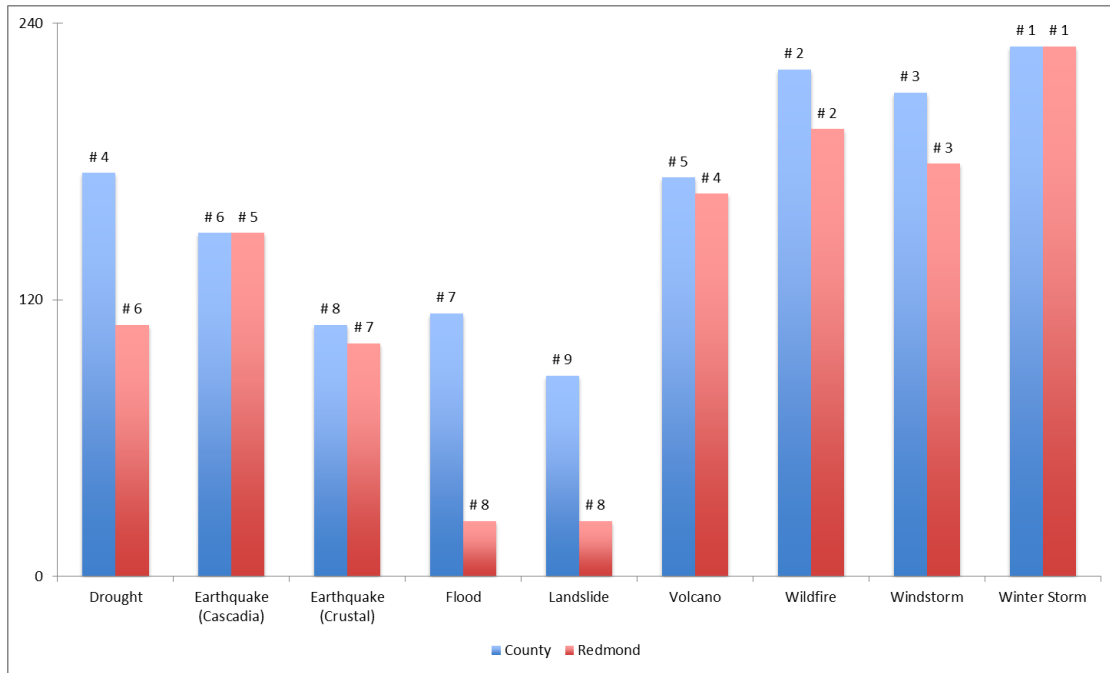
For more information on the Winter Storm Hazard (including history and extent) see the Winter Storm Annex in Volume II.

Summary

The figure below presents a summary of the hazard analysis for the City of Redmond and compares the results to the assessment completed by the Deschutes County NHMP Steering Committee.

In terms of history, probability, vulnerability, and maximum threat, the hazard analysis for the city overall rated their threat to the drought, earthquake (crustal), flood, landslide, volcano, wildfire, and windstorm hazards lower than the County while the earthquake (Cascadia) and winter storm hazards were rated the same as the County's ratings.

Figure RA-2 Overall Hazard Analysis Comparison – Redmond and Deschutes County



Source: City of Redmond NHMP Steering Committee and Deschutes County NHMP Steering Committee, 2021.

Mitigation Plan Mission

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

The mission of the Deschutes County NHMP is:

To promote sound public policy designed to protect people, critical facilities, infrastructure, property, and the environment from natural hazards.

This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the County towards building a safer, more disaster resistant community.

The Redmond steering committee reviewed the 2015 NHMP plan mission statement and agreed it accurately describes the overall purpose and intent of this plan. The Steering Committee believes the concise nature of the mission statement allows for a comprehensive approach to mitigation planning.

Mitigation Plan Goals

Mitigation plan goals are more specific statements of direction that Deschutes 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.

The Redmond Addendum steering committee reviewed and agreed to the 2021 Deschutes County NHMP plan goals. 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 to implement first, should funding become available. Below is a list of the 2021 NHMP goals:

Goal 1 - Protect life and reduce injuries resulting from natural hazards.

Goal 2 - Minimize property damage from natural hazards.

Goal 3 - Minimize damage to critical or essential infrastructure and services from natural hazards.

Goal 4 - Enhance the ability of Deschutes County's economy to rebound quickly from the effects of natural hazard events.

Goal 5 - Minimize project impacts to the environment and utilize natural solutions to protect people and property from natural hazards.

Goal 6 - Enhance the County's capability to implement a comprehensive County wide natural hazards mitigation strategy.

Goal 7 - Motivate the "whole community" to build resilience and mitigate against the effects of natural hazards through engagement, listening, learning, information- sharing, and funding opportunities.

Goal 8 - Eliminate development within mapped hazardous areas where the risks to people and property cannot be practicably mitigated.

Goal 9 - Minimize damage to historic and cultural resources from natural hazards.

Goal 10 - Enhance communication, collaboration, and coordination among agencies at all levels of government, sovereign tribal nations, and the private sector to mitigate natural hazards.

Goal 11 - Mitigate the inequitable impacts of natural hazards by prioritizing and directing resources and investments to build resilience in the most vulnerable populations and the communities least able to respond and recover.

Goal 12 - Develop, integrate, and align natural hazards mitigation and climate adaptation efforts based on the evolving understanding of the interrelationships between climate change and climate-related natural hazard events.

Goal 13 - Reduce repetitive and severe repetitive flood losses.

Goal 14 - Minimize or eliminate potential impacts from dams posing the greatest risk to people, property, and infrastructure

(Note: although numbered the goals are not prioritized.)

Mitigation Plan Action Items

Short- and long-term action items identified through the planning process are an important part of the mitigation plan. Action items are detailed recommendations for activities that local departments, citizens and others could engage in to reduce risk. They address both multi-hazard (MH) and hazard-specific issues. Action items can be developed through a number of sources, including steering committee work sessions, stakeholder interviews, public community forums, surveys, local policies and plans, and regional risk assessments. A description of how the plan's mitigation actions were developed is provided below.

Action Item Worksheets

Each action item has a corresponding action item worksheet describing the activity, identifying the rationale for the project, identifying potential ideas for implementation, and assigning coordinating and partner organizations. The action item worksheets can assist the community in pre-packaging potential projects for grant funding. The worksheet components are described within Volume I, Section 3 (Mitigation Strategy). The City specific action item worksheets are located in Attachment 1, *Action Item Forms*.

The City is also a party to several actions described in the County NHMP; each jurisdiction listed on the County Action Item Forms as an “Affected Jurisdiction” will contribute to and work towards completion of that action as it pertains to their jurisdiction. There are 18 County Action Items that included Redmond as an “Affected Jurisdiction”. For detailed information on each County level action item form see Volume I, Section 3, *Mitigation Strategy* and Volume IV, Appendix A, *Action Item Forms*.

Action Item Development Process

Development of action items was a multi-step, iterative process that involved brainstorming, discussion, review, and revisions. Action items were developed by the steering committee and were influenced by actions identified as part of the Sustainable City Year work program. A number of actions identified by the County steering committee include the City as an affected jurisdiction; these actions are broad actions that include implementation components at both the County and city level. All actions were reviewed by the committee and revised as necessary before becoming a part of this document.

ATTACHMENT I: ACTION ITEM FORMS

Action Item Forms

The action item forms portray the overall action plan framework and identify linkages between the plan goals, partnerships (coordination and partner organizations), and actions. Table RA-9 provides a list of actions for the city. The pages that follow include individual forms for each mitigation action.

Table RA-9 Mitigation Actions

Action Item	High Priority	Timeline	Status	Related Hazards							
				Drought	Earthquake	Flood	Landslide	Volcano	Wildfire	Windstorm	Winter Storm
MH #1	X	Long-Term	Ongoing	X	X	X	X	X	X	X	X
EQ #1		Ongoing	Ongoing		X						
FL #1		Long-Term	Removed			X					

Source: City of Redmond NHMP Steering Committee

Mitigation Action: Multi-hazard #1 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Participate in emergency preparedness and disaster planning with the County, Redmond School District and other organizations to ready the City and Citizens for emergency situations.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input checked="" type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
City/County Comprehensive Plans and Development Codes						
Rationale for Proposal (Why is this important?):						
Public awareness of external events and how to prepare for and deal with them is critical to community preparedness.						
Ideas for Implementation (How will it get done?):			Action Status Report			
The department will work with the U of O Sustainable Cities Initiative in developing a comprehensive emergency preparedness plan for the Cascadia Event. Update and conduct outreach for the City emergency operations plan.			Ongoing (added in 2015). The University of Oregon Sustainable Cities Initiative completed a short report on this (available on the City of Redmond's website).			
Champion/ Responsible Organization:		Community Development				
Internal Partners:			External Partners:			
Police Department, Public Works, Redmond Airport			Deschutes County Emergency Services, Redmond F & R			
Potential Funding Sources:			Estimated cost:		Timeline:	
Sustainable City Year - Budgeted			\$15,000		<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Earthquake #1 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Examine the airport facility needs related to emergency preparedness and its regional designation in the Oregon Resiliency Plan and the Cascadia Event.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
Airport Master Plan, Comprehensive Plan, Facilities Plan						
Rationale for Proposal (Why is this important?):						
Redmond's airport serves all of central Oregon and is the site of the command center.						
Ideas for Implementation (How will it get done?):			Action Status Report			
Examine operational readiness and development of the emergency plans. Program needed expansion and key maintenance efforts.			Added in 2015. Removed from High Priority list. Continue to look for opportunities to build capacity at Redmond Airport as a regional emergency services facility.			
Champion/ Responsible Organization:		Redmond Airport				
Internal Partners:			External Partners:			
Community Development, Public Works			Deschutes County Community Development, Deschutes County Emergency Services, FEMA, OEM, Department of Homeland Security (DHS), City of Redmond			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Resources - Grants, Bonds			To be determined		<input checked="" type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Ongoing				

Mitigation Action: Flood #1 (What do we want to do?)	Alignment with Plan Goals:				High Priority Action Item?
Complete a stormwater drainage study and mitigate problem areas.	<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> Yes
	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input checked="" type="checkbox"/> 8	
	<input checked="" type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:					
Stormwater Master Plan					
Rationale for Proposal (Why is this important?):					
<p>Flash floods occur in Redmond and have the potential to damage structures; the most recent large event occurred in August 2013 and the event of record occurred on June 10-17, 2006. The event of record caused flooding in the streets of downtown and other parts of Redmond.</p> <p>The City does not have an extensive stormwater collection system, rather the city has used underground injection controls (dry wells) and valved interconnections between the storm and sanitary system. During large storm events street flooding is relieved by opening valves to divert stormwater to gravity sanitary sewer pipelines as allowed per the city's discharge permit for the Redmond WPCF. Other areas are relieved with the use of the city's vacuum trucks. (Redmond Wastewater (Collection System) and Water System Master Plan, 2007)</p>					
Ideas for Implementation (How will it get done?):			Action Status Report		
Update existing Stormwater Master Plan			Removed (added in 2015). Recent projects have been completed to address the localized flooding experienced downtown, at the Yew Avenue interchange and at SW Glacier and 25 th Street. Past flooding within Redmond has typically been the result of heavy, localized storm events. As problem areas are identified from these events, projects are developed and incorporated into a 5-year capital projects plan. This is an ongoing process that is managed by Stormwater Division personnel, therefore completing a Stormwater Drainage study is not necessary.		
Champion/Responsible Organization:		Public Works			
Internal Partners:			External Partners:		
Community Development, Engineering			Oregon Water Resources Department		
Potential Funding Sources:		Estimated cost:		Timeline:	
SDC's, grants, Local Resources		\$125,000		<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee			
Action Item Status:		Removed			

ATTACHMENT 2: ACTION ITEM FORM TEMPLATE

Action Item: (What do we want to do?)	Alignment with Plan Goals:	High Priority Action Item?
	1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input type="checkbox"/> Yes
Alignment with Existing Plans/Policies:		
Rationale for Proposed Action Item (why is it important?):		
Ideas for Implementation (how will it get done?):	Action Status Report	
Potential Funding Sources:	Estimated Cost:	Timeline:
		<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)
Coordinating/Lead Organization:		
Internal Partners:	External Partners:	
Form Submitted by:		
Action Item Status		

CITY OF SISTERS ADDENDUM

Introduction

This document serves as the City of Sisters' Addendum to the Deschutes County Natural Hazards Mitigation Plan (NHMP). The City's Addendum is considered part of the County's multi-jurisdictional plan, and meets the following requirements: (1) Multi-jurisdictional Plan Adoption §201.6(c)(5), (2) Multi-jurisdictional Participation §201.6(a)(3), (3) Multi-Jurisdictional Risk Assessment §201.6(c)(2) (iii), and (4) Multi-jurisdictional Mitigation Strategy §201.6(c)(3)(iv).

A description of the city specific planning and adoption process follows, along with detailed community specific action items; for detailed information see Volume IV, Appendix B. Information about the city's risk relative to the County's risk to natural hazards is documented in this addendum's Hazard Analysis and Issue Identification section. The section considers how the city's risk differs from or matches that of the County's; additional information on the Risk Assessment is provided within Volume I, Section 2 of this NHMP.

How was the Plan Developed?

The NHMP was developed by the Deschutes County Natural Hazards Mitigation Plan steering committee, while this addendum was created by the City of Sisters steering committee. The Deschutes County Emergency Manager was designated as the NHMP's convener and will take the lead in implementing, maintaining and updating the plan. Locally, the City of Sisters convened a steering committee for the purpose of developing the city's addendum.

The local steering committee was closely involved throughout the development of the plan and served as the local oversight body for the plan's development. The local steering committee met on one occasion: April 9th, 2021 (see Appendix B for more information). Steering committee members contributed data and reviewed, and provided guidance towards the community profile, risk assessment, mitigation strategy (action items), and implementation and maintenance plan. The addendum reflects effort from the formal meeting and during subsequent informal meetings between members of the steering committee and with Central Oregon Intergovernmental Council (COIC).

An open public involvement process is essential to the development of an effective plan. In order to develop a comprehensive approach to reducing the effects of natural disasters, the planning process should include opportunities for the public, neighboring communities, local and regional agencies, as well as, private and nonprofit entities to comment on the plan.¹ COIC provided a publicly accessible project webpage for the general public in order to make meeting materials and contact information available throughout the update process. In

¹ Code of Federal Regulations, Chapter 44. Section 201.6, subsection (b). 2015

addition, Deschutes County and the City of Sisters provided press releases on their websites to encourage the public to offer feedback on the plan update.

In addition, COIC administered a public opinion survey to obtain additional input from the public regarding the County’s risks, vulnerabilities, hazards history, and mitigation strategies. See Volume IV, Appendix F for more information.

Updating the mitigation plan is a requirement to gain eligibility for the Federal Emergency Management Agency’s Pre-Disaster Mitigation, Hazard Mitigation, and Flood Mitigation Assistance grant Programs. This project is funded through the Federal Emergency Management Agency’s (FEMA) FY12 Pre-Disaster Mitigation Competitive Grant Program (PDMC – PL-10-OR-2012-002).

The Sisters Addendum to the Deschutes County NHMP was adopted on October 13, 2021 and approved by FEMA on October 28, 2021. The Deschutes MNHMP was approved by FEMA on October 28, 2021, the plan is effective for Deschutes County and Sisters through October 27, 2026.

For more information on the composition of the steering committee and the process see this NHMP’s Volume I, Acknowledgements and Executive Summary, and Volume IV, Appendix B.

Action Item Matrix

The City’s action items were first developed through a two-stage process in 2015 by the local steering committee, facilitated by Oregon Partnership for Disaster Resilience (OPDR). In 2021, the local steering committee, facilitated by COIC, updated the status of existing action items and added one new action item. In addition, there are 25 County Action Items that include Sisters as an “Affected Jurisdiction.” For additional information see the discussion near the end of this document.

The City’s actions are listed below in matrix format. For more detailed information on each action, see the action forms within Attachment 1 of this addendum.

Table SA-1 City of Sisters Action Items

2021 Action Item	High Priority	Mitigation Action Title	Lead Organization	Partner Organization(s)	Timeline	Status
Multi-Hazard #1	X	Identify and remove hazardous trees which pose a potential threat of coming into contact with overhead electric transmission or distribution lines during a high wind event.	Public Works	Internal: - External: Central Electric Cooperative	Ongoing	New
Flood #1		Explore options to replace pressure sewer line at Locust Street Bridge or construct temporary emergency bypass.	Public Works	Internal: - External: USFS, USACE, Silver Jackets, OWRD, ODOT, UDWC, DRC	Long-Term	Complete
FL #2		Increase dimensions of drainage culverts in flood-prone areas.	Public Works	Internal: Community Development External: USACE, Silver Jackets, OWRD, ODOT, DRC, UDWC	Long-Term	Remove
FL #3		Conduct a viability study for an early warning system for Whychus Creek flooding.	Deschutes County Emergency Services	Internal: City of Sisters, Sisters-Camp Sherman Fire External: OWRD, OEM, USFS, USGS	Medium-Term	New
FL #4		Pursue updated information to inform inundation mapping and flood risk along Whychus Creek.	Deschutes County	Internal: Community Development, Public Works, Sisters Community Development and Public Works External: USGS, USACE, FEMA, DOGAMI, OEM, DLCD, OSU-Cascades	Short-Term	New
Wildfire #1	X	Explore adoption of updated defensible space and enhanced building code requirements like R327.4.	City of Sisters	Internal: Sisters-Camp Sherman Fire; Deschutes County; Cities of Bend, La Pine, and Redmond External: USFS, ODF	Short-Term	New
WF #2	X	Increase participation of community members in fire insurance and maintaining defensible space to maintain eligibility.	Deschutes County Emergency Services	Internal: City of Sisters, Sisters-Camp Sherman Fire; Project Wildfire External: USFS, ODF	Short-Term	New
WF #3		Increase water storage to account for increased growth/wildfire	Public Works	Internal: Sisters-Camp Sherman Fire External: USFS	Medium-Term	New

Source: City of Sisters NHMP Steering Committee, 2021

How Will the Plan be Implemented?

The City Council will be responsible for adopting the City of Sisters addendum to the Deschutes County NHMP. This addendum designates a coordinating body and a convener to oversee the development and implementation of action items. Because the city addendum is considered part of the County plan, the city will look for opportunities to partner with the County to maintain the plan, and coordinate mitigation efforts through the implementation of action items, etc. The City's steering committee will convene after re-adoption of the City of Sisters addendum annually with the County every fall. For more details on the meeting schedule and process, see Volume I, Section 4. The City's Community Development Director will serve as the convener and will be responsible for convening the local steering committee. The convener will also remain active in the County's planning process. The steering committee will seek to involve senior staff and decision makers throughout the duration of the five-year implementation and maintenance of the NHMP addendum.

Implementation through Existing Programs

Many of the Natural Hazards Mitigation Plan's recommendations are consistent with the goals and objectives of the city's existing plans and policies. Where possible, the City of Sisters will implement the NHMP's recommended actions through existing plans and policies. Plans and policies already in existence have support from local residents, businesses, and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, allowing them to adapt to changing conditions and needs. Implementing the NHMP's action items through such plans and policies increases their likelihood of being supported and implemented.

The City of Sisters currently has the following plans that relate to natural hazard mitigation:

Table SA-2 Existing Plans

Jurisdiction	Document	Year
City of Sisters	Comprehensive Plan	2021
City of Sisters	Transportation System Plan	2018
City of Sisters	Development Code (Flood, Section 2.10)	2020
City of Sisters	Greater Sisters Area Emergency Operations Plan	2009
City of Sisters	Greater Sisters Country CWPP*	2020
City of Sisters	Water System Master Plan	2017
City of Sisters	Water Management and Conservation Plan	2016
City of Sisters	Wastewater System Capital Facilities Plan	2016

Source: City of Sisters Steering Committee, 2021

The steering committee and the community's leadership have the option to add or implement action items at any time. This allows the steering committee to consider mitigation strategies as new opportunities arise, such as funding for action items that may not be of the highest priority. When new actions are identified, they should be documented using an action item form (see Attachment 2). Once a proposed action form has been submitted to the convener, the action will become part of the City's addendum.

Continued Public Participation

Keeping the public informed of the city's efforts to reduce the city's risk to future natural hazards events is important for successful plan implementation and maintenance. The city is committed to involving the public in the plan review and updated process. The City Addendum along with the County Plan will be posted on-line on COIC's website (<https://www.coic.org/emergency-preparedness/natural-hazard-mitigation-plans/deschutes-County-nhmp/>), as well as the County and City websites, so that the public may view the plan at any time.

In addition, natural hazards information dissemination is conducted throughout the year when opportunities present themselves via the city offices and website.

Plan Maintenance

The Deschutes County Natural Hazards Mitigation Plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. During the County plan update process, the city will also review and update its addendum. The convener will be responsible for convening the steering committee to address the questions outlined below.

- Are there new partners that should be brought to the table?
- Are there new local, regional, state, or federal policies influencing natural hazards that should be addressed?
- Has the community successfully implemented any mitigation activities since the plan was last updated?
- Have new issues or problems related to hazards been identified in the community?
- Are the actions still appropriate given current resources?
- Have there been any changes in development patterns that could influence the effects of hazards?
- Have there been any significant changes in the community's demographics that could influence the effects of hazards?
- Are there new studies or data available that would enhance the risk assessment?
- Has the community been affected by any disasters? Did the plan accurately address the impacts of this event?

These questions will help the steering committee determine what components of the mitigation plan need updating. The steering committee will be responsible for updating any deficiencies found in the plan.

The remainder of this addendum includes three sections:

1. Community Profile and Asset Identification,
2. Hazard Identification and Risk Assessment, and
3. Mitigation Strategy section.

COMMUNITY PROFILE

ASSET IDENTIFICATION

This section provides city specific asset identification. For information on the characteristics of Sisters, in terms of geography, environment, population, demographics, employment and economics, as well as housing and transportation see Volume IV, Appendix C, *Community Profile*. Many of these community characteristics can affect how natural hazards impact communities and how communities choose to plan for natural hazard mitigation. Considering the city specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

We live in a place with a varied geography and communities. We would like to recognize and acknowledge the indigenous land of the Confederated Tribes of Warm Springs, Molalla, Paiute, Klamath, Modok, Yahooskin Band of Snake Indians, and Tribes of Middle Oregon. We want to recognize the people that came before us and honor their traditions and stewardship of the land. Acknowledgement is a simple, powerful way of showing respect for Indigenous People's history and culture.

Asset Identification

The following assets were identified by the steering committee in 2021:

Critical and Essential Facilities

- Deschutes County Sheriff's Office Emergency Management has access to an inventory of critical and essential facilities.

Deschutes County, State, and Federal Critical and Essential Facilities (located in Sisters):

- Deschutes County Sheriff's Office Substation – 703 N Larch Avenue
- Oregon Department of Forestry – 16721 Pine Tree Lane
- United States Forest Service – Pine Street and US 20
- Oregon Department of Transportation maintenance station – 16415 HWY 126
- Sisters Post Office – 694 N Larch Street

Special Districts in Sisters

- Sisters-Camp Sherman Rural Fire Protection District – 301 S Elm Street
- Sisters Parks and Recreation District – 1750 W. McKinney Butte Road
- Three Sisters Irrigation District – 68000 Hwy 20
- Deschutes Public Library – 11 N. Cedar Street

Sisters School District

- Sisters Elementary School – 611 E Cascade Avenue
- Sisters Middle School – 15200 McKenzie Highway
- Sisters High School – 1700 McKinney Butte Road
- Sisters School District – 525 East Cascade Avenue
- Bus Maintenance Facility – 15100 McKenzie Highway

Social Service Providers

- Please see <https://www.thrivecentraloregon.org/services> for a comprehensive list of resource providers throughout Central Oregon, including Sisters.

Population

Sisters' estimated population is 3,220 people. The city's population has grown an estimated 1,182 people or 58% since the 2010 Census.² Sisters' acknowledged Coordinated Population Forecast is 5,169 people by the year 2043, which represents an increase of 1,899 people or 58% between 2020 and 2043.³

Land Use

The City of Sisters' acknowledged comprehensive plan is the "Sisters Urban Area Comprehensive Plan." The Oregon Land Conservation and Development Commission first acknowledged the plan in 1982. The City last completed a major update of the plan in 2005. The City is currently updating the Comprehensive Plan, and expects to adopt it in fall of 2021. The City implements the plan through the Sisters Development Code, which was last comprehensively updated in 2021.

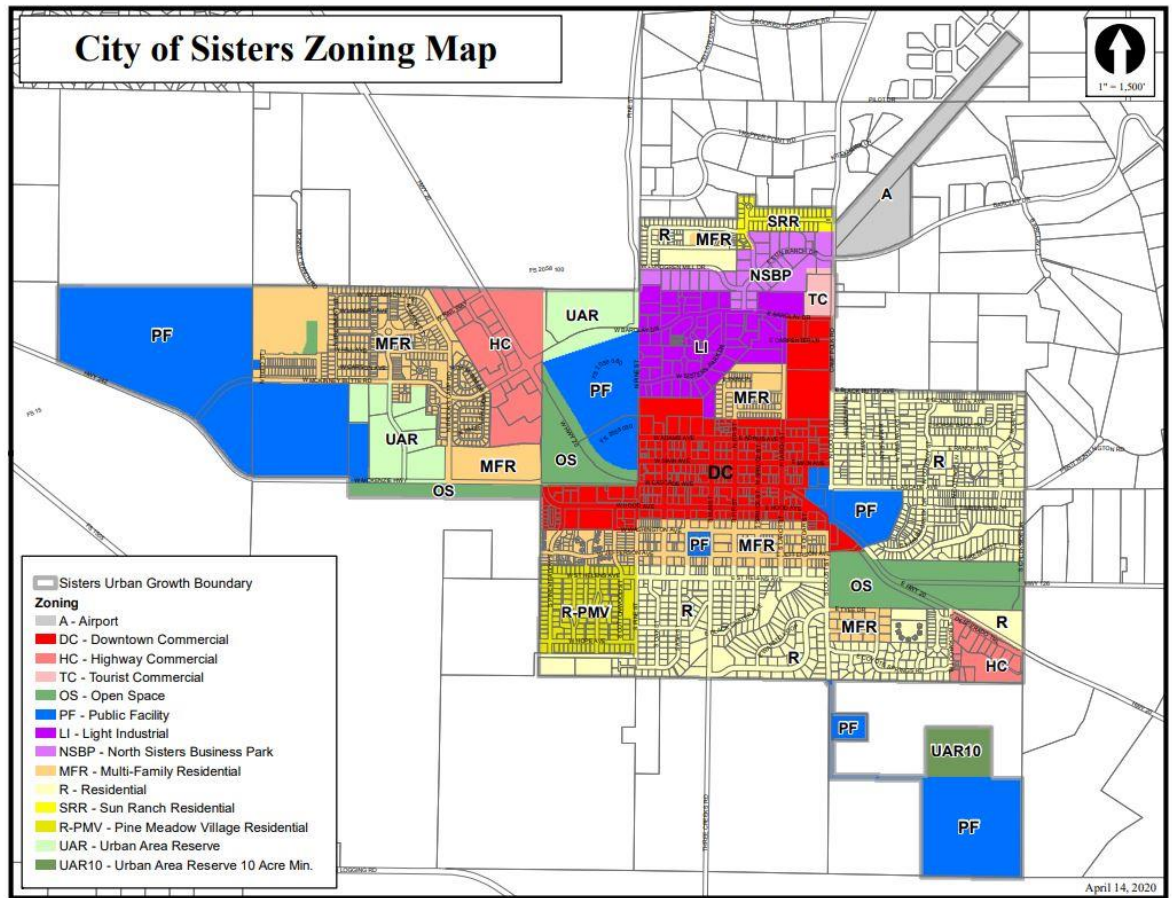
The City continues to grow at a steady pace with most residential construction being developed as single-family detached homes. Existing master planned subdivisions are experiencing new construction as well infill construction occurring on historically platted lots in Sisters. There is a strong interest by the community and a recognized need for more affordable housing units to be constructed and recently there has been an increase in the construction of multi-family units.

Figure SA-1 below shows the city's zoning map (April 2020):

² Portland State University, Population Research Center, "Annual Population Estimates", 2020.

³ 2004 Coordinated Population Forecast for Deschutes County – updated 2018

Figure SA-1 Zoning Map



Source: City of Sisters (2020)

Parks and Open Space

The City of Sisters owns and manages a variety of parks to serve different functions and needs in the community. The existing parks system provides a range of park types and recreation opportunities. The City currently owns and maintains nine developed park facilities, which comprise 14.01 acres of developed parkland, and three undeveloped parcels, which comprise 5.59 acres of undeveloped parkland. Two new parks of 0.5 and 1.8 acres each have been dedicated by private developers. In addition, the Sisters planning area contains 33.76 linear miles of trails and 28.65 acres of open space.

Economy

Sisters is the second smallest city in Deschutes County, however, it has more than doubled its population since 2010 and is expected to grow by another 63% by 2043. The Community

has a growing trade-sector economy⁴. The table below demonstrates the top ten industries in the City of Sisters based on total and export employment.

Table SA-3 Top Ten Industries City of Sisters

Industry	Total Employment
Accommodation and Food Services	432
Retail Trade	388
Agriculture, Forestry, Fishing, and Hunting	140
Educational Services	138
Health Care and Social Assistance	127
Construction	120
Professional, Scientific, and Technical Services	92
Other Services	90
Wood Manufacturing	78
Food Manufacturing	76
Industry	Export Employment
Accommodation and Food Services	273
Retail Trade	189
Agriculture, Forestry, Fishing, and Hunting	128
Educational Services	75
Wood Manufacturing	73
Food Manufacturing	43
Other Services	23
Construction	13
Arts, Entertainment, and Recreation	12
Transportation	10

Source: City of Sisters Economic Opportunities Analysis

The seasonally adjusted unemployment rate for Deschutes County was 8.6% for 2020.

Cultural and Historic Resources

The sites and structures listed below (Table SA-3) represent the city’s official list of historic places compiled by the city and County, and approved by the Oregon Land Conservation and Development Commission.

⁴ Economic Development for Central Oregon website, <https://www.edcinfo.com/>, accessed April 2021.

Table SA-4 Historic Sites – City of Sisters

Historic Site/ Name	Location
Aitkens Building (Drugstore)	101 E Cascade Avenue
Hotel Sisters	190 E Cascade Avenue
Leithauser Store	251 E Cascade Avenue
Hardy Allen House	401 E Main Avenue

Source: Deschutes County and City of Sisters Historic Preservation Program: 2015-2020 Strategic Plan

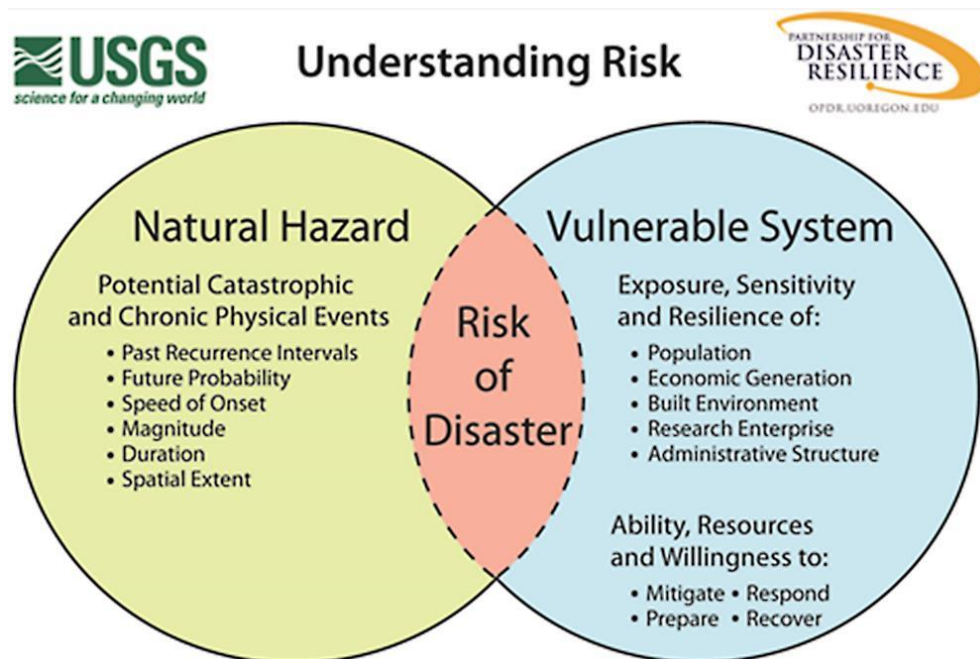
RISK ASSESSMENT

This section of the NHMP addendum addresses 44 CFR 201.6(b)(2) - Risk Assessment. In addition, this chapter can serve as the factual basis for addressing Oregon Statewide Planning Goal 7 – Areas Subject to Natural Hazards. Assessing natural hazard risk has three phases:

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

The information presented below, along with hazard specific information presented elsewhere in this addendum, within the Hazard Annexes (Volume II), and community characteristics presented in the Community Profile (Appendix C), will be used as the local level rationale for the risk reduction actions identified in this addendum. The risk assessment process is graphically depicted in Figure SA-2 below. Ultimately, the goal of hazard mitigation is to reduce the area where hazards overlap vulnerable systems.

Figure SA-2 Understanding Risk



Source: Oregon Partnership for Disaster Resilience

Hazard Analysis Methodology

This NHMP utilizes a hazard analysis methodology that was first developed by FEMA circa 1983, and gradually refined by the Oregon Military Department's Office 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%.

This 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 shown in the table below. See Volume I, Section (3 Risk Assessment) for more information.

Hazard Analysis

On April 9th, 2021, the City of Sisters addendum steering committee developed their hazard vulnerability assessment (HVA), using the County's HVA as a reference. Changes from the County's HVA were made where appropriate to reflect distinctions in vulnerability and risk from natural hazards unique to the City of Sisters, which are discussed throughout this addendum.

Table SA-5 shows the HVA matrix for Sisters showing each hazard listed in order of rank from high to low. 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.

Table SA-5 Hazard Analysis Matrix – City of Sisters

Hazard	Maximum				Total Threat Score	Hazard Rank
	History	Vulnerability	Threat	Probability		
Wildfire	20	50	100	70	240	# 1
Winter Storm	20	50	100	70	240	# 1
Windstorm	20	50	90	70	230	#3
Flood	16	50	90	63	219	#4
Volcano	2	40	100	21	163	#5
Earthquake (Cascadia)	2	40	100	7	149	#6
Drought	8	15	70	56	149	#6
Earthquake (Crustal)	2	20	80	14	116	#8
Landslide	2	5	20	7	34	#9

Source: City of Sisters NHMP Steering Committee, 2021

Three chronic hazards (wildfire, winter storm, and windstorm) rank as the top three hazard threats to the city (Top Tier). The flood, volcano, Cascadia Earthquake, and drought comprise the next highest ranked hazards (Middle Tier), while crustal earthquake and landslide hazards comprise the lowest ranked hazards (Bottom Tier).

Table SA-6 categorizes the probability and vulnerability scores from the hazard analysis for the city and compares the results to the assessment completed by the Deschutes County NHMP Steering Committee (areas of differences are noted with **bold** text within the city ratings).

Table SA-6 Probability and Vulnerability Comparison

Hazard	Sisters		County	
	Probability	Vulnerability	Probability	Vulnerability
Drought	High	Low	High	Low
Earthquake (Cascadia)	Low	High	Low	High
Earthquake (Crustal)	Low	Moderate	Low	Moderate
Flood	High	High	High	Low
Landslide	Low	Low	Low	Low
Volcano	Low	High	Low	High
Wildfire	High	High	High	High
Windstorm	High	High	High	High
Winter Storm	High	High	High	High

Source: City of Sisters NHMP Steering Committee and Deschutes County NHMP Steering Committee, 2021

Drought

A drought is a period of drier than normal conditions that results in water-related problems. 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.

The steering committee determined that the city's probability for drought is **high** (which is the same as the County's rating) and that their vulnerability to drought is **low** (which is the same as the County's rating).

The city has ample high quality groundwater supplies fed by four production wells four and has a 1.6 million gallon reservoir for storage.⁵ There are no issues with groundwater supply and the annual recharge to the aquifer is high, however, long-term water level trends show supply (based on existing water rights of 5.8 mgd) will be limited for expected population growth and water usage by the year 2030 (estimated). The city's total pumping capacity is 6.6 mgd, which is estimated to provide enough production water until 2035. The City also has 3 emergency back-up generators, for a total emergency pumping capacity of 3060 gpm or 4.4 mgd. Exceeding the current available water supply at the Average Daily Demand projection is estimated to be year 2050.⁶ In addition, the city has one 12-inch transmission mains that provide water to the city from the reservoirs and a total of 40.1 miles of transmission and distribution mains (4" to 16") mostly built after 1993⁷. The city currently provides information to residents on how to conserve water and also has a four-stage water curtailment plan that progresses from voluntary to mandatory and minor to major depending on the severity of the water shortage (see Section 4 of the Sisters Water Management and Conservation Plan, 2016).

For more information on the Drought Hazard (including history and extent) see the Drought Annex in Volume II.

Earthquake

Oregon and the Pacific Northwest in general are susceptible to earthquakes from four sources: 1) the off-shore Cascadia Fault Zone; 2) deep intra-plate events within the subducting Juan de Fuca Plate; 3) shallow crustal events within the North American Plate; and 4) earthquakes associated with volcanic activity.⁸

The areas most susceptible to ground amplification and liquefaction have young, soft alluvial sediments, found along river and stream channels. The extent of the damage to structures and injury and death to people will depend upon the type of earthquake, proximity to the epicenter and the magnitude and duration of the event.

The steering committee HVA evaluated both crustal earthquakes and a Cascadia earthquake. The steering committee determined that the city's probability of experiencing a crustal earthquake is **low** (which is the same as the County's rating) and that their

⁵ City of Sisters Website, accessed April 28, 2015.

⁶ Sisters Water System Master Plan Update (2017) and Sisters Water Management and Conservation Plan (2016).

⁷ Ibid.

⁸ Taylor, George H. and Chris Hannan. The Oregon Weather Book. Corvallis, OR: Oregon State University Press, 1999.

vulnerability to a crustal earthquake is **moderate** (which is the same as the County's rating). The steering committee determined that the city's (and State's) probability of experiencing a Cascadia earthquake is **low** (which is the same as the County's rating) and that their vulnerability to a Cascadia earthquake is **high** (which is the same as the County's rating).

Two-thirds of Sisters' buildings were built after 1990 and the codification of seismic codes. Sisters is not particularly susceptible to liquefaction, and is not expected to experience very strong to violent shaking in an earthquake event (see Volume II, Tables II-5 and II-6). As such, the city's vulnerability to earthquakes is reduced because of its relatively new infrastructure and buildings in combination with the particular geology of the area. However, the city considers itself to have high vulnerability to a Cascadia earthquake event due to secondary effects of the hazard, including access to transportation routes, energy resources, communications, and the need to assist with refugees from the damage that is expected west of the Cascades.

Information on specific buildings' estimated seismic resistance, determined by DOGAMI in 2007, is shown in Tables SA-7 below. The table displays the rankings of all facilities within the city's jurisdiction; each "X" represents one building within that ranking category. It is important to note that these assessments have not continued beyond 2007. Therefore, some buildings have been added, moved, changed, etc. since the assessment but are not reflected in the scores. However, buildings completed after 2007 would likely score low risk given new earthquake standard codes.

Of the school facilities evaluated by DOGAMI using RVS, two (2) have very high (100% chance) collapse potential; Sisters Elementary School is considered among the most vulnerable to seismic collapse. Of the public safety facilities evaluated, none have very high (100% chance) collapse potential; however, four (4) buildings have high (greater than 10% chance) collapse potential; including the Sisters-Camp Sherman RFPD, which also functions as the city's Emergency Coordination Center (ECC).

Table SA-7 Rapid Visual Survey Scores

Facility	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Schools				
Sisters Elementary School (611 E Cascade, Sisters)	XX			X
Sisters Middle School (15200 McKenzie Hwy, Sisters)				X
Sisters High School (1700 W McKinney Butte Rd, Sisters)	X			
Public Safety				
Black Butte RFPD (13511 Hawks Beard, Sisters)			XX	
Sisters-Camp Sherman RFPD (301 S Elm, Sisters)			XX	
Sisters-Camp Sherman RFPD (17233 Buffalo Dr, Sisters)	X			
Sisters-Camp Sherman RFPD (69351 Lariat, Sisters)	X			
Deschutes County Sheriff's Office (703 N Larch, Sisters)	X			

Source: DOGAMI 2007. Open File Report 0-07-02. Statewide Seismic Needs Assessment Using Rapid Visual Assessment.

For more information on the Earthquake Hazard (including history and extent) see the Earthquake Annex in Volume II.

Flood

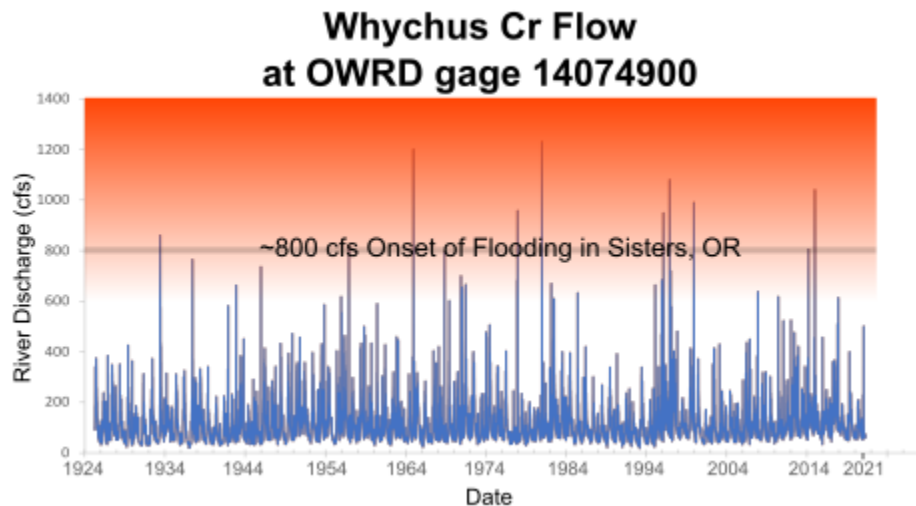
Flooding results when rain and snowmelt creates water flow that exceeds the carrying capacity of rivers, streams, channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall. Flooding can be aggravated when rain is accompanied by snowmelt and frozen ground; the spring cycle of melting snow is the most common source of flood in the region. The principal types of flood that occur in Sisters include: spring/snow melt flooding, warm winter rain-on-snow flooding, ice jams, flash floods, and dam failure.

The steering committee determined that the city's probability for flood is **high** (which is the same as the County's rating) and that their vulnerability to flood is **high** (which is higher than the County's rating).

The City's principle flood concern is from Whychus Creek, which has a flood season that extends from November through April (all of the large events have occurred in November and December). The largest flood event occurred on December 25, 1980 with a peak discharge of 2,000 cfs; the next largest flood event occurred in December 1964, with a peak discharge of 1,980 cfs.⁹ Another major flooding event occurred in November 1968, with a peak discharge of 1,840 cfs. All of these flood events caused property damage, bank erosion, and flooding and debris deposition on agricultural land.

Figure SA-3 below shows the river discharge history of Whychus Creek at OWRD gage 14074900, approximately 4 miles upstream from the city of Sisters, OR. Flooding in Sisters has been known to begin at discharges of around 800 cfs. The recurrence of floods of this magnitude are approximately every ten years.

Figure SA-3 River Discharge History of Whychus Creek



Source: OWRD, April 2021

⁹ Deschutes County Flood Insurance Study (2007)

The Elm Street Bridge within Sisters is susceptible to overtopping by a 100-year flood event.¹⁰ Obstructions to flood flows within Whychus Creek also create an additional hazard, which could lead to bank overtopping and flooding of land that is at the same or lower elevations.¹¹ Sisters has a portion of its community that is developed near the special flood hazard area that is susceptible to damage (see Figures SA-3 and SA-4 below); future updates will provide analysis of the properties impacted by flood including studies conducted as part of County Action Flood #7.

Particular infrastructure potentially impacted by flood includes the: Sisters Fire Station, area schools, Sisters commercial/residential district, and the public works facility.

Figure SA-4 Sisters Floodway/Floodplain Area



Source: <http://dial.deschutes.org/>, accessed April 21, 2021

Because the city of Sisters is located at the base of the Three Sisters Volcanoes, it is particularly vulnerable to any catastrophic events triggered on the slopes of the Cascade Mountains. Carver Lake, located at 7,800 feet on the east slope of South Sister Park volcano, contains about 740 acre-feet (900,000 cubic meters or 32 million cubic feet) of water and poses a unique, though very low hazard to the city. In the event of a hypothetical large slope failure off of South Sister (Note: geological mapping has not identified that significant portions of South Sisters is susceptible to failure), the landslide material could

¹⁰ Ibid.

¹¹ Ibid.

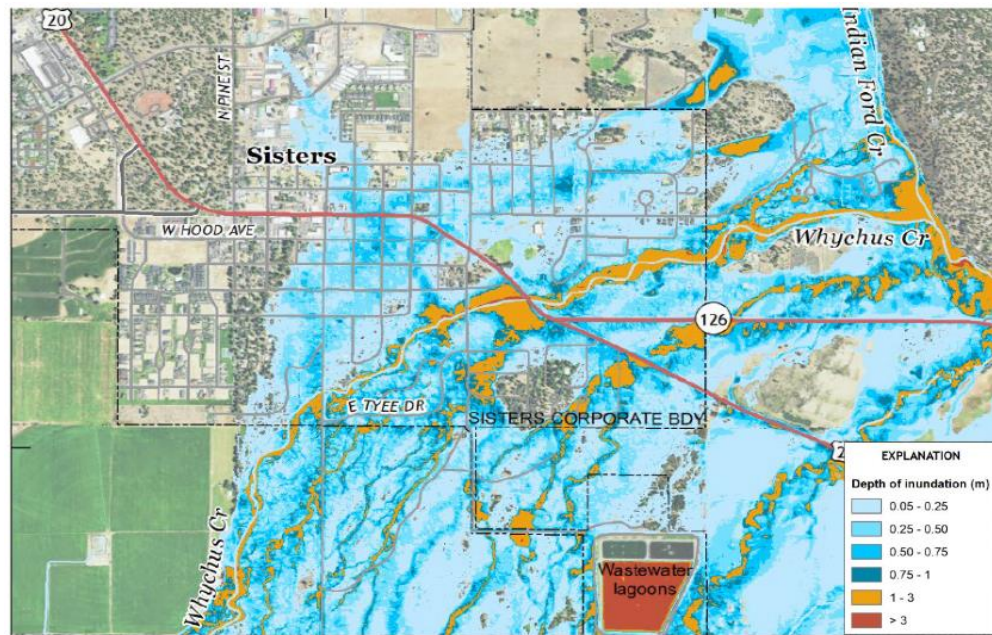
catastrophically “splash” Carver Lake contents into Whychus Creek headwaters and inundate parts of Sisters.

Much of the initial concern that Carver Lake poses a significant natural hazard to the city of Sisters came from a now-debunked hypothesis that the moraine partially supporting Carver Lake is unstable and could catastrophically fail, similar to other moraine-dammed lakes in the Cascades.¹² A 2018 USGS study discusses the newer conclusion that the material holding in Carver Lake is stable and does not pose a failure risk, but because Carver Lake sits in a precarious position above Sisters, the USGS revisited the study with more modern modelling techniques.

The 2-dimensional flood modeling analysis used a hypothetical landslide to evacuate all the waters of Carver Lake (since moraine failure was no longer considered a viable trigger to Carver Lake flooding). The 2-D model leads to “clear water” flow into Sisters (George, Addendum to 2018 paper), not factoring in entrainment of debris and sediment (which would undoubtedly occur and slow down/attenuate the flood). The model results are a “worst-case scenario” of 0.05-0.25 m (2-10 inches) flooding in most of Sisters. In and directly adjacent to the main channel (approximately the 100-year floodplain), there could be as much as 1-3 m (3.3-9.9 feet) of flooding, noting that the higher depth values are from the bottom of Whychus Creek bed to its banks (i.e., the model is not predicting ~10 feet of water at residential properties).

¹² Launen, USGS 1987, Source: Hydrologic Hazards Along Whychus Creek From a Hypothetical Failure of the Glacial Moraine Impacting Carver Lake Near Sisters, Oregon—USGS Open File Report 87-41; O’Connor, J.E., Hardison, J.H., and Costa, J.E., 2001, Debris flows from failures of Neoglacial-age dams in the Three Sisters and Mount Jefferson wilderness areas, Oregon, U.S. Geological Survey Professional Paper 1606.

Figure SA-5 USGS 2-dimensional modeling results for flooding triggered by a hypothetical landslide of off South Sister landing in Carver Lake and evacuating all of its contents



Source: George et al, Seamless numerical simulation of a hazard cascade in which a landslide triggers a dam-breach flood and consequent debris flow, 7th International Conference on Debris-Flow Hazards Mitigation, 2018

If an event of this magnitude happened, locally high velocities, damming, erosion, and sediment deposition could cause considerable property damage and possible loss of life in Sisters.

Action items are included to address the concerns with flooding in Sisters; in addition, County Action Flood #7 impacts the city and concerns the flood potential on Whychus Creek (see Appendix A for more information).

National Flood Insurance Program (NFIP)

The Deschutes County Flood Insurance Rate Maps (FIRMs) were modernized in 2007. The table below shows that as of April 2021, Sisters has 31 National Flood Insurance Program (NFIP) policies in force and zero (0) paid claims. The city’s last Community Assistance Visit (CAV) was April 26, 2004. The city is not a member of the Community Rating System (CRS). The table displays the number of policies by building type and shows that the majority of residential structures that have flood insurance policies are single-family homes (31) and that there are no non-residential structures with flood insurance policies. Additionally, there are two (2) properties that are minus rated A-zone properties.

The community repetitive flood loss record for Sisters does not include any repetitive flood loss, or severe repetitive flood loss buildings and has not had any repetitive loss claims.

Table SA-8 Flood Insurance Detail

Jurisdiction	Current FIRM Date	Initial FIRM Date	Total Policies	Pre-FIRM Policies	Policies by Building Type				Minus Rated A Zone
					Single Family	2 to 4 Family	Other Residential	Non-Residential	
Sisters	9/28/2007	9/29/1986	31	2	31	0	0	0	2

Jurisdiction	Insurance in Force	Total Paid Claims	Pre-FIRM Claims Paid	Substantial Damage Claims	Repetitive Loss Buildings	Severe Repetitive Loss Buildings	Total Paid Amount	CRS Class Rating	Last CAV

* Portion of entire county under county jurisdiction
 NP - Not Participating NA - Information not Available/ Not Applicable

Source: Information compiled by Department of Land Conservation and Development, April 2021.

For more information on the Flood Hazard (including history and extent) see the Flood Annex in Volume II.

Landslide

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.

The steering committee determined that the city’s probability for landslide is **low** (which is the same as the County’s rating) and that their vulnerability to landslide is **low** (which is the same as the County’s rating).

The city has had no problems with landslides within city limits in known history and is located in a generally stable area.

For more information on the Landslide Hazard (including history and extent) see the Landslide Annex in Volume II.

Volcano

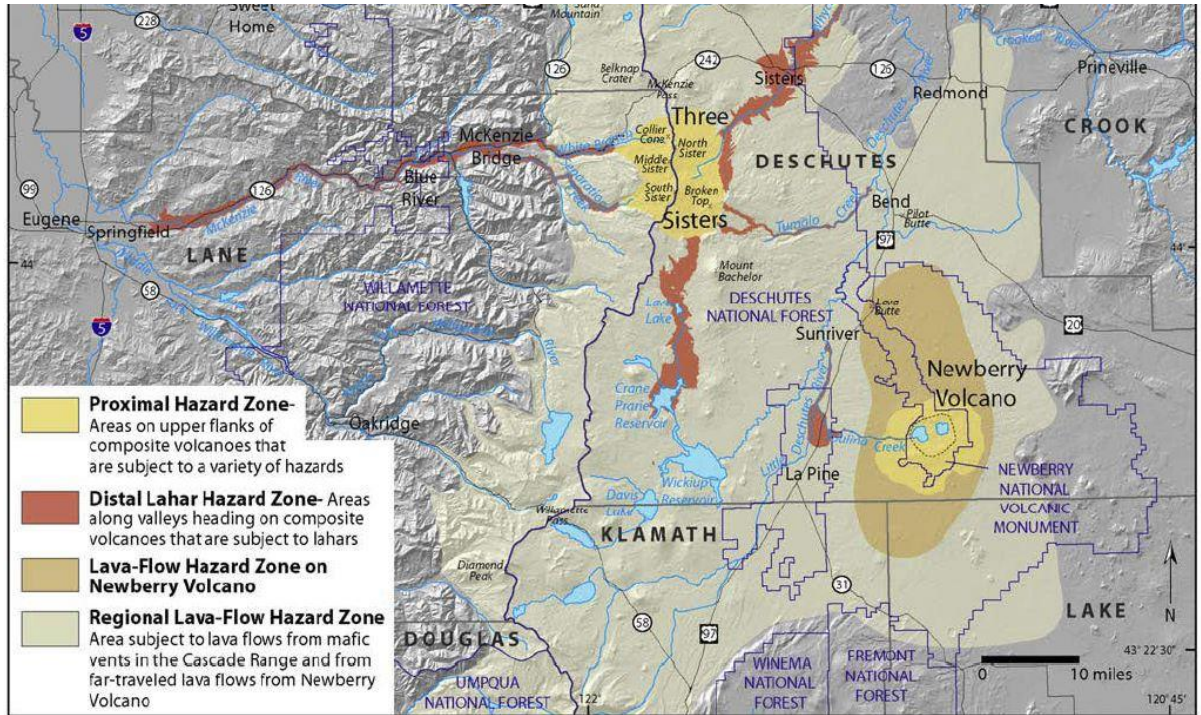
The Pacific Northwest lies within the “ring of fire,” an area of very active volcanic activity surrounding the Pacific Basin. Volcanic events occur regularly along the ring of fire, in part because of the movement of the Earth’s tectonic plates. Volcanic events have the potential to coincide with numerous other hazards including ash fall, earthquakes, lava flows, pyroclastic flows, lahars, and debris flows, and landslides.

The steering committee determined that the city’s probability for volcanic event is **low** (which is the same as the County’s rating) and that their vulnerability to volcanic event is **high** (which is the same as the County’s rating).

Were a volcanic event to occur in the Cascades region of Oregon, Sisters could be at risk for ash fall, regional lava flows, and lahars, depending on the severity of the event and the

direction of the wind. Due to Sisters' proximity to the Three Sisters, in relation to other areas within eastern Oregon, the effects of a volcanic event may be more disruptive to normal business, economic activity, and health than to other regions of the County. Figure SA-6 shows the regional volcano hazards that indicate that Sisters is within a moderate hazard zone; see also Figure II-16 within Volume II, *Hazard Annexes*.

Figure SA-6 Volcano Hazards



Source Central Cascades Volcano Coordination Plan, 2018.

For more information on the Volcano Hazard (including history and extent) see the Volcano Annex in Volume II.

Wildfire

Wildfires occur in areas with large amounts of flammable vegetation that require a suppression response due to uncontrolled burning. Fire is an essential part of Oregon's ecosystem, but can also pose a serious threat to life and property particularly in the state's growing rural communities. Wildfire can be divided into three categories: interface, wildland, and firestorms. The increase in residential development in interface areas has resulted in greater wildfire risk. Fire has historically been a natural wildland element and can sweep through vegetation that is adjacent to a combustible home. New residents in remote locations are often surprised to learn that in moving away from built-up urban areas, they have also left behind readily available fire services providing structural protection.

The steering committee determined that the city's probability for wildfire is **high** (which is the same as the County's rating) and that their vulnerability to wildfire is **high** (which is the same as the County's rating).

Wildfires occur regularly in the vicinity of Sisters including the Black Crater (9,412 acres) and the Lake George (5,652 acres) fires in 2006, the GW fire (8,570 acres) in 2007, The Pole Creek fire (26,795 acres) in 2012, and the Milli fire (24,079 acres) in 2017. (For a complete list of recent large wildfires see Table II-7 and Figure II-19 within Volume II, Hazard Annex and the Greater Sisters CWPP.) The Greater Sisters Country Community Wildfire Protection Plan (CWPP, 2020) relies upon (1) The Oregon Wildfire Risk Explorer tool (https://tools.oregonexplorer.info/OE_HtmlViewer/index.html?viewer=wildfireplanning) and (2) local knowledge and input to determine fire risk within the Greater Sisters Wildland-Urban Interface (WUI). For more information on wildfire risk and fuels reduction projects see the Greater Sisters Country CWPP and visit the Project Wildfire website: <http://www.projectwildfire.org/>.

For more information on the Wildfire Hazard (including history and extent) see the Wildfire Annex in Volume II and the Greater Sisters Country CWPP.

Windstorm

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Although windstorms can affect the entirety of Deschutes 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 storm related debris.

The steering committee determined that the city's probability for windstorm is **high** (which is the same as the County's rating) and that their vulnerability to windstorm is **high** (which is the same as the County's rating).

Sisters is a relatively windy place due to its location close to the Cascade peaks and passes. As tall trees in Sisters age and weaken with the stress of a changing climate and development, we may see more than the "normal" number of trees come down during wind events. Many trees have fallen in the last few years during wind events, luckily with no injuries. As population density rises however, the chances of injury and death increase. Windstorms are often associated with microbursts (thunderstorms). Regionally, windstorms have been coupled with wildfires, with wind pushing an existing fire or toppling trees onto power lines starting new fires - or both simultaneously. The community is vulnerable to damage to utility lines, including fiber optics, which are key to the economic sectors of the community.

For more information on the Windstorm Hazard (including history and extent) see the Windstorm Annex in Volume II.

Winter Storm

Severe winter storms can consist of rain, freezing rain, ice, snow, cold temperatures, and wind. They originate from troughs of low pressure offshore that ride along the jet stream during fall, winter, and early spring months. Severe winter storms affecting Deschutes County typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from November through March.

The steering committee determined that the city's probability for winter storm is **high** (which is the same as the County's rating) and that their vulnerability to winter storm is **high** (which is the same as the County's rating).

Sisters is located at a higher elevation east of the Cascades, which is a major contributor to winter storms. Major winter storms are frequent in the Sisters area and have been known to cause damage. Two major winter storms in 2017 and 2019 created massive snow loads that caused multiple roof cave-ins throughout the County.

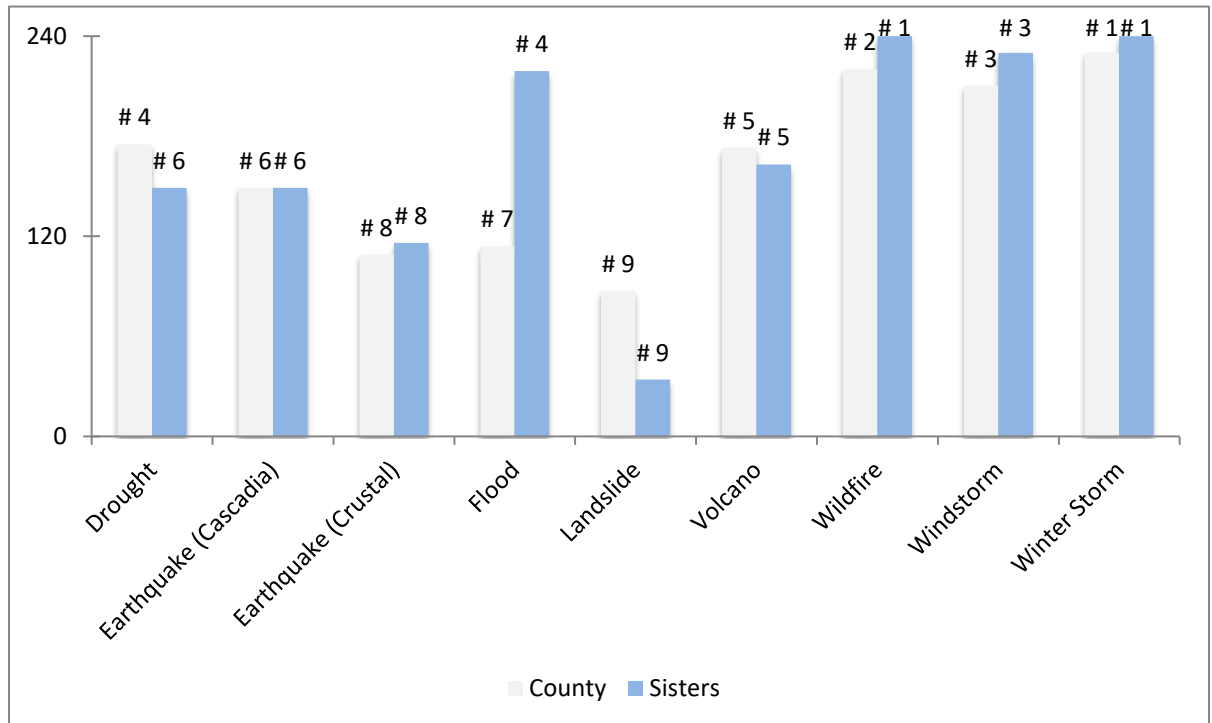
Major winter storms also have the potential to impact economic activity. Road closures on Highway 97, or the passes to the Willamette Valley (Highways 58 and 20/126), due to winter weather are a common occurrence and can interrupt commuter and large truck traffic. The city budgets funds for seasonal winter storm needs, such as clearing roads. *For more information on the Winter Storm Hazard (including history and extent) see the Winter Storm Annex in Volume II.*

Summary

The figure below presents a summary of the hazard analysis for the City of Sisters and compares the results to the assessment completed by the Deschutes County NHMP Steering Committee.

In terms of history, probability, vulnerability, and maximum threat, the hazard analysis for the city overall rated their threat to the flood and wildfire hazards higher than the County, and rated their threat to drought less than the County. All other hazards were rated the same as the County's ratings. The top three hazards for the city and the County are wildfire, windstorm, and winter storm.

Figure SA-7 Overall Hazard Analysis Comparison – Sisters and Deschutes County



Source: City of Sisters NHMP Steering Committee and Deschutes County NHMP Steering Committee, 2021.

Mitigation Plan Mission

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

The mission of the Deschutes County NHMP is:

To promote sound public policy designed to protect people, critical facilities, infrastructure, private property, and the environment from natural hazards.

This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the County towards building a safer, more disaster resistant community.

The Sisters steering committee reviewed the 2021 NHMP plan mission statement and agreed it accurately describes the overall purpose and intent of this plan. The Steering Committee believes the concise nature of the mission statement allows for a comprehensive approach to mitigation planning.

Mitigation Plan Goals

Mitigation plan goals are more specific statements of direction that Deschutes 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.

The Sisters Addendum steering committee reviewed and agreed to the 2021 Deschutes County NHMP plan goals. 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 to implement first, should funding become available. Below is a list of the 2021 NHMP goals:

Goal 1 - Protect life and reduce injuries resulting from natural hazards.

Goal 2 - Minimize property damage from natural hazards.

Goal 3 - Minimize damage to critical or essential infrastructure and services from natural hazards.

Goal 4 - Enhance the ability of Deschutes County's economy to rebound quickly from the effects of natural hazard events.

Goal 5 - Minimize project impacts to the environment and utilize natural solutions to protect people and property from natural hazards.

Goal 6 - Enhance the County’s capability to implement a comprehensive County wide natural hazards mitigation strategy.

Goal 7 - Motivate the “whole community” to build resilience and mitigate against the effects of natural hazards through engagement, listening, learning, information-sharing, and funding opportunities.

Goal 8 - Eliminate development within mapped hazardous areas where the risks to people and property cannot be practicably mitigated.

Goal 9 - Minimize damage to historic and cultural resources from natural hazards.

Goal 10 - Enhance communication, collaboration, and coordination among agencies at all levels of government, sovereign tribal nations, and the private sector to mitigate natural hazards.

Goal 11 - Mitigate the inequitable impacts of natural hazards by prioritizing and directing resources and investments to build resilience in the most vulnerable populations and the communities least able to respond and recover.

Goal 12 - Develop, integrate, and align natural hazards mitigation and climate adaptation efforts based on the evolving understanding of the interrelationships between climate change and climate-related natural hazard events.

Goal 13 - Reduce repetitive and severe repetitive flood losses.

Goal 14 - Minimize or eliminate potential impacts from dams posing the greatest risk to people, property, and infrastructure.

(Note: although numbered the goals are not prioritized.)

Mitigation Plan Action Items

Short- and long-term action items identified through the planning process are an important part of the mitigation plan. Action items are detailed recommendations for activities that local departments, citizens and others could engage in to reduce risk. They address both multi-hazard (MH) and hazard-specific issues. Action items can be developed through a number of sources such as steering committee work sessions, stakeholder input, etc. A description of how the plan’s mitigation actions were developed is provided below.

Action Item Worksheets

Each action item has a corresponding action item worksheet describing the activity, identifying the rationale for the project, identifying potential ideas for implementation, and assigning coordinating and partner organizations. The action item worksheets can assist the community in pre-packaging potential projects for grant funding. The worksheet components are described within Volume I, Section 3 (Mitigation Strategy). The City specific action item worksheets are located in Attachment 1, *Action Item Forms*.

The City is also a party to several actions described in the County NHMP; each jurisdiction listed on the County Action Item forms as an “Affected Jurisdiction” will contribute to and work towards completion of that action as it pertains to their jurisdiction. **There are 25 County Action Items that include Sisters as an “Affected Jurisdiction.”** For detailed information on each County level action item form see Volume I, Section 3, *Mitigation Strategy* and Volume IV, Appendix A, *Action Item Forms*.

Action Item Development Process

Development of action items was a multi-step, iterative process that involved brainstorming, discussion, review, and revisions by the steering committee. A number of actions identified by the County steering committee include the City as an affected jurisdiction; these actions are broad actions that include implementation components at both the County and city level. All actions were reviewed by the committee and revised as necessary before becoming a part of this document.

ATTACHMENT I: ACTION ITEM FORMS

Action Item Forms

The action item forms portray the overall action plan framework and identify linkages between the plan goals, partnerships (coordination and partner organizations), and actions. Table SA-9 provides a list of actions for the city. The pages that follow include individual forms for each mitigation action.

Table SA-9 Mitigation Actions

Action Item	High Priority	Timeline	Status	Related Hazards							
				Drought	Earthquake	Flood	Landslide	Volcano	Wildfire	Windstorm	Winter Storm
MH #1	x	Ongoing	New							x	x
FL #1		Long-Term	Completed			x					
FL #2		Long-Term	Removed			x					
FL #3		Medium-Term	New			x					
FL #4		Short-Term	New			x					
WF #1	x	Short-Term	New							x	
WF #2	x	Short-Term	New							x	
WF#3		Medium-Term	New							x	

Source: City of Sisters NHMP Steering Committee

Action Item: MH#1 (Sisters) (What do we want to do?)		Alignment with Plan Goals:	High Priority Action Item?
Identify and remove hazardous trees which pose a potential threat of coming into contact with overhead electric transmission or distribution lines during a high wind event		1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input checked="" type="checkbox"/> Yes
Alignment with Existing Plans/Policies:			
Rationale for Proposed Action Item (why is it important?):			
Identify and remove hazardous trees, as defined by the U.S. Forest Service, which could contact the electric utility's transmission or distribution lines during a high wind event. High wind events can blow nearby hazardous trees and their branches into power lines, sparking fires. Removing the hazardous trees reduces the threat of fire ignition.			
Ideas for Implementation (how will it get done?):		Action Status Report	
Have the city's contract arborist survey existing trees to identify those which pose a potential threat of coming into contact with overhead electric transmission or distribution lines during a high wind event.		New in 2021	
Potential Funding Sources:	Estimated Cost:	Timeline:	
Local	TBD	<input checked="" type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)	
Coordinating/Lead Organization:	City of Sisters Public Works		
Internal Partners:		External Partners:	
		Central Electric Cooperative	
Form Submitted by:	Brent Ten Pas (CEC), 2021		
Action Item Status:	NEW		

Mitigation Action: Flood #1 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Explore options to replace pressure sewer line at Locust Street Bridge or construct temporary emergency bypass.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input checked="" type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
Wastewater System Capital Facilities Plan (2016)						
Rationale for Proposal (Why is this important?):						
Sewer line on upstream side of bridge is a pressure line, if impacted by floodwaters/ debris the sewer for the entire town would be shut down.						
The Disaster Mitigation Act of 2000 requires communities to identify actions and projects that reduce the effects of hazards on the community, particularly to buildings and infrastructure [201.6(c)(3)(ii)].						
Ideas for Implementation (How will it get done?):			Action Status Report			
Replace sewer line with a system that goes under the creek. Collaborate with USFS to remove debris that collects within the creek. Install emergency temporary bypass piping connections and vaults and purchase bypass equipment.			Added in 2015 and completed in 2021			
Champion/ Responsible Organization:		Public Works				
Internal Partners:			External Partners:			
			U.S. Forest Service, USACE, OWRD, Silver Jackets, Deschutes River Conservancy, Upper Deschutes Watershed Council			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources, Silver Jackets, FEMA					<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Complete				

Mitigation Action: Flood #2 (What do we want to do?)		Alignment with Plan Goals:				High Priority Action Item?
Increase dimensions of drainage culverts in flood-prone areas.		<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Alignment with Existing Plans/Policies:						
Capital Improvement Plan						
Rationale for Proposal (Why is this important?):						
A number of stormwater facilities within the community need to be increased in dimension to dispose of stormwater and limit flooding.						
Ideas for Implementation (How will it get done?):			Action Status Report			
Develop local stormwater BMPs to address flooding issues in flood susceptible areas in the city.			Added in 2015 and removed in 2021 because Larger culverts were installed just north of Sisters to help mitigate localized flooding from the Trout Creek drainage. No other culvert replacements or expansions within Sisters appear to be necessary at this time to address any localized potential flood impacts.			
Champion/ Responsible Organization:		Public Works				
Internal Partners:			External Partners:			
Community Development			USACE, OWRD, Silver Jackets, ODOT, Deschutes River Conservancy, Upper Deschutes Watershed Council			
Potential Funding Sources:			Estimated cost:		Timeline:	
Local Funding Resources, Silver Jackets, FEMA					<input type="checkbox"/> Ongoing <input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long-Term (3-5 years)	
Form Submitted by:		2015 NHMP Committee				
Action Item Status:		Removed				

Action Item: FL#3 (Sisters) (What do we want to do?)		Alignment with Plan Goals:	High Priority Action Item?
Conduct a Viability Study for an early warning system for Whychus Creek flooding.		1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input checked="" type="checkbox"/> 9 <input type="checkbox"/> 10 <input checked="" type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input checked="" type="checkbox"/>	<input type="checkbox"/> Yes
Alignment with Existing Plans/Policies:			
County EOP, Sisters Country EOP			
Rationale for Proposed Action Item (why is it important?):			
Whychus Creek is subject to flooding as a result of rain-on-snow events and failure of moraine dam at Carver Lake (Three Sisters Wilderness). Whychus Creek flows through the City of Sisters as well as unincorporated Deschutes County. Flooding has the potential to impact homes, businesses, recreational areas and critical infrastructure.			
Ideas for Implementation (how will it get done?):		Action Status Report	
Initiate feasibility study of an early warning system on Whychus Creek.		New in 2021	
Potential Funding Sources:	Estimated Cost:	Timeline:	
Local, state, federal	\$50,000	<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input checked="" type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)	
Coordinating/Lead Organization:	DCSO EM		
Internal Partners:		External Partners:	
City of Sisters, Sisters-Camp Sherman Fire District		OWRD, OEM, USFS, USGS	
Form Submitted by:	Nathan Garibay, 2021		
Action Item Status:	NEW		

Action Item: WF #1 (Sisters) (What do we want to do?)		Alignment with Plan Goals:	High Priority Action Item?
City of Sisters explore adoption of updated defensible space and enhanced building code requirements like R327.4		1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input checked="" type="checkbox"/> Yes
Alignment with Existing Plans/Policies:			
R327.4 is included within the Oregon Residential Specialty Code as an optional code for local adoption.			
Rationale for Proposed Action Item (why is it important?):			
Expanding development within the wildland urban interface coupled with increasing fire frequency and severity are resulting in increasing risk to the community. Home to home ignitions in the wildland urban interface is a growing problem in Oregon. In the Labor Day fires of 2020, 38% of the homes destroyed were located within incorporated cities.			
Ideas for Implementation (how will it get done?):		Action Status Report	
Deschutes County should work with other counties and cities to support statewide adoption of enhanced defensible space and building standards for communities identified as high or extreme wildfire risk. Deschutes County and local cities should also consider adoption of more stringent local rules where appropriate.		New in 2021	
Potential Funding Sources:	Estimated Cost:	Timeline:	
Local	No Cost	<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input type="checkbox"/> Medium (2-5 years) <input checked="" type="checkbox"/> Short (0-2 years)	
Coordinating/Lead Organization:	City of Sisters		
Internal Partners:		External Partners:	
		Sisters-Camp Sherman Fire District, Deschutes County, City of Bend, City of La Pine, City of Redmond, USFS, ODF	
Form Submitted by:		Roger Johnson, 2021	

Action Item Status:	NEW
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Action Item: WF #2 (Sisters) (What do we want to do?)		Alignment with Plan Goals:	High Priority Action Item?
Increase participation of community members in fire insurance and maintaining defensible space.		1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input checked="" type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input checked="" type="checkbox"/> Yes
Alignment with Existing Plans/Policies:			
Future Recovery Plan			
Rationale for Proposed Action Item (why is it important?):			
Other events in Oregon have identified the challenge that many community members are uninsured or underinsured, which limits their ability to recover from wildfire.			
Ideas for Implementation (how will it get done?):		Action Status Report	
Public Education regarding the importance of adequate insurance coverage and creating defensible space to maintain coverage.		New in 2021	
Potential Funding Sources:	Estimated Cost:	Timeline:	
Local	TBD	<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input type="checkbox"/> Medium (2-5 years) <input checked="" type="checkbox"/> Short (0-2 years)	
Coordinating/Lead Organization:	Deschutes County Sheriff's Office Emergency Management		
Internal Partners:		External Partners:	
City of Sisters Administration, Sisters-Camp Sherman Fire District, Project Wildfire		ODF, USFS	
Form Submitted by:	Nathan Garibay, 2021		

Action Item Status:	NEW		
Action Item: WF #3 (Sisters) (What do we want to do?)	Alignment with Plan Goals:		High Priority Action Item?
Increase water storage to account for increased growth/wildfire	1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input type="checkbox"/> Yes	
Alignment with Existing Plans/Policies:			
City of Sisters 2017 Water System Master Plan			
Rationale for Proposed Action Item (why is it important?):			
Due to the larger than anticipated growth since the City's Water System Master Plan was last updated there is a need to construct a new 2-million-gallon water storage reservoir to provide increased firefighting flows and standby water supply in case of catastrophic failures to the City's production wells.			
Ideas for Implementation (how will it get done?):		Action Status Report	
Update existing Water Master Plan Perform preliminary design Procure Grants/Loans Develop final design and CMGC contract Construct the facility		New in 2021	
Potential Funding Sources:	Estimated Cost:	Timeline:	
Water SDC's FHMA Grant OSR Grant	\$2,500,000	<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input checked="" type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)	
Coordinating/Lead Organization:	City of Sisters Public Works		
Internal Partners:		External Partners:	
		Sisters Camp Sherman Rural Fire Dept; USFS	
Form Submitted by:	Paul Bertagna, 2021		
Action Item Status:	NEW		

ATTACHMENT 2: ACTION ITEM FORM TEMPLATE

Action Item: (What do we want to do?)	Alignment with Plan Goals:	High Priority Action Item?
	1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input type="checkbox"/> Yes
Alignment with Existing Plans/Policies:		
Rationale for Proposed Action Item (why is it important?):		
Ideas for Implementation (how will it get done?):	Action Status Report	
Potential Funding Sources:	Estimated Cost:	Timeline:
		<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)
Coordinating/Lead Organization:		
Internal Partners:		External Partners:
Form Submitted by:		
Action Item Status:		

VOLUME IV: MITIGATION RESOURCES

APPENDIX A: ACTION ITEM FORMS

The following table lists the action item number, timeline, status, priority, affected jurisdictions, and applicable hazards.

Note: See addenda for each city's action item forms and action item prioritization.

Table A-I Action Item Table of Contents and Affected Jurisdiction

Action Item	Timeline	Status	Priority	Jurisdiction					Related Hazard								
				Deschutes	Bend	La Pine	Redmond	Sisters	Drought	Earthquake	Flood	Landslide	Volcano	Wildfire	Windstorm	Winter Storm	
MH #1	Ongoing	Ongoing		X	X	X	X	X	X	X	X	X	X	X	X	X	X
MH #2	Ongoing	Ongoing		X	X	X	X	X	X	X	X	X	X	X	X	X	X
MH #3	Ongoing	Ongoing		X	X	X	X	X	X	X	X	X	X	X	X	X	X
MH #4	Long Term	Ongoing	Yes	X	X	X	X	X	X	X	X			X	X	X	X
MH #5	Long Term	Ongoing	Yes	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MH #6	Long Term	Ongoing		X	X	X	X	X								X	X
MH #7	Long Term	Ongoing		X	X	X	X	X							X	X	X
MH #8	Medium Term	New	Yes	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MH #9	Long Term	New		X	X	X	X	X	X	X	X	X	X	X	X	X	X
EQ #1	Long Term	Deferred		X	X	X	X	X	X								
EQ #2	Long Term	Ongoing		X	X	X	X	X	X								
EQ #3	Short Term	New		X	X	X	X	X	X								
FL #1	Ongoing	Ongoing		X	X	X		X		X							
FL #2	Long Term	Deferred		X	X					X							
FL #3	Ongoing	Ongoing		X	X	X		X		X							
FL #4	Long Term	Ongoing		X	X	X		X		X							
FL #5	Long Term	Ongoing		X	X	X		X		X							
FL #6	Long Term	Deferred		X	X					X							
FL #7	Long Term	Ongoing		X				X		X							
VE #1	Long Term	Deferred		X									X				
WF #1	Ongoing	Ongoing	Yes	X	X	X	X	X							X		
WF #2	Ongoing	Ongoing	Yes	X	X	X	X	X							X		
WF #3	Ongoing	Ongoing	Yes	X	X	X	X	X							X		
WF #4	Medium Term	New	Yes	X	X	X	X	X							X		
WS #1	Ongoing	Ongoing		X	X	X	X	X								X	
WS #2	Ongoing	Ongoing		X	X	X	X	X								X	
WS #3	Ongoing	Ongoing		X	X	X	X	X								X	

Source: Deschutes County Steering Committee, Updated 2021

Action Item: Multi-hazard #1		Alignment with Plan Goals:				High Priority Action Item?
Integrate training and education initiatives from the Deschutes County Natural Hazards Mitigation Plan into existing regulatory documents and programs where appropriate.		<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11		
Affected Jurisdictions:						
<input checked="" type="checkbox"/> Deschutes County		<input checked="" type="checkbox"/> Bend		<input checked="" type="checkbox"/> Redmond		
		<input checked="" type="checkbox"/> La Pine		<input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:						
City/ County Comprehensive Plans and Development Codes						
Rationale for Proposed Action Item:						
<p>The extreme population growth in the County and the region continues to bring people to the area who are not familiar with the climate, terrain, culture, etc.</p> <p>Additionally, this growth has placed new demands on the capacity of existing systems of support such as volunteer fire departments, city governments, and the service industry including hospitals, Red Cross and others.</p> <p>It is critical that the majority of the population be informed and skilled in mitigation efforts, particularly related to wildland fire and severe winter storms. Efforts placed in public awareness, education and training will strengthen the County's capacity to address an event should it happen; heighten understanding and knowledge of how to prevent and mitigate impacts; and strengthen the culture and sense of responsibility for life, property and safety.</p>						
Ideas for Implementation:						
Public education and training for staff should routinely be conducted. Resorts and other businesses related to tourism should be included.						
Distribute education materials to home and business owners that support initiatives to reduce the risk of loss from natural hazards.						
Coordinating Organization:		Deschutes County Natural Hazards Mitigation Committee				
Internal Partners:			External Partners:			
Emergency Services, Community Development, County Forester, Road Department, Public Works, Cities			ODF, American Red Cross, OSU Cascades			
Potential Funding Sources:		Estimated cost:		Timeline:		
Partner with OSU Cascades, Local Funding Resources				<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing		
Form Submitted by:		2010 NHMP Committee				
Action Item Status:		Ongoing				

Action Item: Multi-hazard #2	Alignment with Plan Goals:				High Priority Action Item?
Pursue coordination of mitigation initiative development, planning, and resource allocation (funding).	<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input type="checkbox"/> 8	
	<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input checked="" type="checkbox"/> 11		
Affected Jurisdictions:					
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters					
Alignment with Existing Plans/Policies:					
City/ County Comprehensive Plans and Development Codes					
Rationale for Proposed Action Item:					
<p>The County has a good history of working together and building and sustaining systems of coordination. This is a result of facing events such as severe wildland fires and winter storms historically and recently. Stakeholders developing this plan concur that placing emphasis on coordinating efforts among public-private, geographic, and multi-interests is a sound investment in building capacity to mitigate hazards, using all resources to their greatest potential, and providing a basis for good communication among a wide range of individuals, groups, agencies and businesses.</p>					
Ideas for Implementation:					
<p>Establish a clear role for the Deschutes County Natural Hazards Mitigation Committee that results in a sustainable process for implementing, monitoring and evaluating mitigation activities.</p> <p>Integrate hazard mitigation initiatives into City and County Comprehensive Plans. Completed in 2011 for Deschutes County (review of natural hazards regulations is underway, 2015)</p> <p>Integrate planning between cities and county where appropriate.</p> <p>Integrate other possible natural hazards not specifically included in this plan.</p> <p>Advance coordination of resource and fund development among cities and private land owners where appropriate mitigation plans mutually benefit.</p> <p>Advance coordination efforts among and with home and business owners and emergency management actions that result in reducing risk of loss from natural hazards.</p>					
Coordinating Organization:	Deschutes County Natural Hazards Mitigation Committee				
Internal Partners:			External Partners:		
Emergency Services, Community Development, County Forester, Road Department, Public Works			ODF, American Red Cross, OSU Cascades, USFS		
Potential Funding Sources:		Estimated cost:		Timeline:	
County and Cities, Grants, Local Funding Resources				<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing	
Form Submitted by:	2010 NHMP Committee				

Action Item Status:	Ongoing
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Action Item: Multi-hazard #3	Alignment with Plan Goals:				High Priority Action Item?
Strengthen understanding of the probability of natural hazards, by continuing to support research specific to the region.	<input checked="" type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
	<input checked="" type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
	<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Affected Jurisdictions:					
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters					
Alignment with Existing Plans/Policies:					
Central Cascades Volcano Coordination Plan (2019) Currently in process of updating 2015 CCVC Plan					
Rationale for Proposed Action Item:					
<p>While indicators of the potential for earthquake and volcanic eruption events are evident, the probability of these events occurring is low based on current studies. Scientists continue to study activities surrounding these hazards and document their findings. It will continue to be a priority for this research to continue in order to learn more about the vulnerability of the region, potential impact, and recommendations for additional mitigation actions.</p> <p>The Central Cascades Volcano Coordination Plan (2019) is complete but does not currently have a local champion and has not been authorized by the participating jurisdictions. Kickoff meeting was 02/27/15.</p>					
Ideas for Implementation:					
<p>Continue to work with the scientific community to review existing and emerging conditions related to natural hazards identified in the Deschutes County NHMP.</p> <p>Integrate research findings into county and local planning efforts.</p> <p>Integrate natural hazards not included in this plan that are identified by research.</p>					
Coordinating Organization:		Deschutes County Natural Hazards Mitigation Committee			
Internal Partners:			External Partners:		
-			OSU Cascades, DOGAMI, USGS, ACOE, FEMA, DLCD, OEM, University of Oregon		
Potential Funding Sources:			Estimated cost:		Timeline:
USGS, Counties (Deschutes, Jefferson, Linn, Lane), OSU Cascades, Local Funding Resources					<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:		2010 NHMP Committee			
Action Item Status:		Ongoing			

Action Item: Multi-hazard #4		Alignment with Plan Goals:	High Priority Action Item?
Assess power grid and determine methods to improve resiliency and encourage community preparedness for power loss.		<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input checked="" type="checkbox"/> Yes
Affected Jurisdictions:			
<input checked="" type="checkbox"/> Deschutes County		<input checked="" type="checkbox"/> Bend	<input checked="" type="checkbox"/> Redmond
		<input checked="" type="checkbox"/> La Pine	<input checked="" type="checkbox"/> Sisters
Alignment with Existing Plans/Policies:			
Rationale for Proposed Action Item:			
<p>The County relies on a range of energy sources to support and protect local residents, businesses, and government facilities. Accordingly, securing supplies of energy (e.g., electricity, gasoline, diesel fuel, natural gas, propane) to critical facilities/infrastructure, especially during emergency events, are of crucial importance to all segments of the community. An energy assurance plan is essentially a plan for how the County will recover and restore energy services to critical functions and facilities/infrastructure within a predetermined time after a partial or complete energy supply interruption. The Plan identifies critical facilities and critical infrastructure needing back-up power generation capacity to ensure continued operation during emergency events. The Plan establishes short-term communication protocols, actions and priorities by which critical facilities/infrastructure will be re-energized after a disruption, as well as long-term strategies for making critical facilities and critical infrastructure less vulnerable to disruptions of mainline energy sources.</p>			
Ideas for Implementation:		Actions Taken Since 2015	
Develop a Local Energy Assurance Plan		<p>Ongoing - CEC resiliency improvements Projects resulting in decreased outages on CEC's system:</p> <ul style="list-style-type: none"> · pole and underground cable replacement · enhanced vegetation management <p>Projects allowing for future growth and redundancy to St. Charles and surrounding health services district:</p> <ul style="list-style-type: none"> · Substation capacity upgrade in Bend · Additional capacity enhancements planned 	
Coordinating Organization:	Deschutes County Emergency Services		
Internal Partners:		External Partners:	
Public Works, Planning, Roads		Utility Companies, U.S. DOE, OEM	
Potential Funding Sources:		Estimated cost:	Timeline:
FEMA PDM, U.S. Department of Energy's Local Energy Assurance Planning Initiative,			<input type="checkbox"/> Short Term (1-2 years)

other grants, Local Funding Resources		<input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2015 NHMP Committee	
Action Item Status:	Ongoing	

Action Item: Multi-hazard #5	Alignment with Plan Goals:	High Priority Action Item?
Develop continuity of operations plans to ensure continued operation in the event of a natural hazard emergency.	<input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input checked="" type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:		
City and County Emergency Operations Plans		
Rationale for Proposed Action Item:		
<p>Deschutes County is vulnerable to a number of different natural hazards that could affect the administration and management of local government. Developing continuity of operations plans for the County will assist in maintaining a basic level of government to continue to provide needed services within the community.</p> <p>According to the Florida Division of Emergency Management, continuity of operations is accomplished through the development of plans, comprehensive procedures, and provisions for alternate facilities, personnel, resources, interoperable communications, and vital records/databases. The plan establishes policy and guidance to ensure the execution of the organization’s most essential functions in any event which requires the relocation of selected personnel and functions to an alternate facility.</p> <p>Research conducted by Richard Wilson has shown that staff turnover is likely to occur after a disaster. Veteran staff is critical after a disaster. It is important to prevent turnover so that existing personnel do not have to take on extra responsibilities during an already stressful time. Continuity planning can also help lessen turnover by ensuring competitive salaries and benefits and by reducing the amount of stress staff will have to endure.</p> <p>The Disaster Mitigation Act of 2000 requires communities to develop actions that reduce the impact of a natural hazard [201.6(c)(3)(ii)]. Developing a continuity of operations plan will diminish the effects of a natural disaster by providing the cities and County of Deschutes with a framework for continuing operations in a potentially chaotic situation.</p>		
Ideas for Implementation:	Actions Taken Since 2015	
<p>Research and review completed continuity of operations plans to provide a foundation of expected content and issues to review.</p> <p>Utilize existing OEM Manuals and Templates available on their website (http://www.oregon.gov/OMD/OEM/pages/plans_train/coop.aspx)</p> <p>The COOP should ensure shelter housing for critical staff and family members such as County officials, public works employees, emergency response, and others.</p> <p>Assess and prioritize critical positions and resources vital to the continuance of important County</p>	<p>Ongoing - maintenance phase for the County - supporting cities in doing this. Have developed County plan. Paused due to COVID.</p>	

functions. Incorporate COOP into the existing Emergency Operations Plans where applicable.		
Coordinating Organization:	Deschutes County Emergency Services	
Internal Partners:	External Partners:	
Public Works, Planning, Roads	OEM	
Potential Funding Sources:	Estimated cost:	Timeline:
State Homeland Security Project, Local Funding Resources		<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2015 NHMP Committee	
Action Item Status:	Ongoing	

Action Item: Multi-hazard #6	Alignment with Plan Goals:	High Priority Action Item?
Develop code language to mitigate the harmful impact of hazard trees located on private and/ or vacant property.	<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input checked="" type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:		
Deschutes County Code		
Rationale for Proposed Action Item:		
<p>Educating property owners about how to prevent power outages on their private property can help reduce impacts of windstorm events on these homeowners.</p> <p>Overhead electrical lines are subject to high winds and winter storm damage. The risk is higher on the lines going to a mountaintop or peak.</p> <p>All of Deschutes County is at risk for winter storms. Due to the multitude of variables, such as wind speed, direction, and temperature, each storm is capable of causing extensive damage in any part of the County.</p> <p>High winds can topple trees and break limbs which in turn can result in power outages and disrupt telephone, computer, and TV and radio service.</p> <p>Windstorms affect Deschutes County on nearly a yearly basis.</p> <p>During winter storm access to the line by the utility is difficult. This difficulty delays the time for restoration of power to Deschutes County residents.</p> <p>The Disaster Mitigation Act of 2000 requires communities to develop comprehensive actions to reduce the impacts of natural hazards.[201.6(c)(3)(ii)] Educating property owners on how to properly maintain trees to prevent power loss on power lines off the right of way will reduce the impact of severe weather in Deschutes County.</p>		
Ideas for Implementation:	Actions Taken Since 2015	
<p>Gather information about the maintenance and removal of hazardous trees.</p> <p>Work with the community and partners to identify areas that are prone to damage from nearby trees and perform the necessary maintenance or removal of those trees.</p> <p>Create a hazardous tree inventory.</p> <p>Work with the community and Public Works Department to identify high wind and icing areas from previous outages and apply for grants to underground utilities in those areas (see MH #7)</p>	Added in 2015; Ongoing in 2021	
Coordinating Organization:	Deschutes County Emergency Services	
Internal Partners:	External Partners:	

County Forester, Community Development, Public Works		Electric Utilities, ODF	
Potential Funding Sources:		Estimated cost:	Timeline:
Local Funding Resources			<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2015 NHMP Committee		
Action Item Status:	Ongoing		

Action Item: Multi-hazard #7	Alignment with Plan Goals:	High Priority Action Item?
Continue and enhance windstorm resistant construction methods where possible to reduce damage to utilities and critical facilities from windstorms. In part, this may be accomplished by encouraging electric utility providers to convert existing overhead lines to underground lines.	<input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:		
Rationale for Proposed Action Item:		
<p>Overhead electrical lines are subject to high winds and winter storm damage. The risk is higher on the lines going to a mountaintop or peak. Most of the services at the top are communication sites. The communication sites are used by ODOT, State Police, county sheriff, emergency services, telephone utilities and cell phone companies. During a disaster the sites are vital for communication. During winter storm access to the line by the utility is difficult and this difficulty delays the time for restoration of power to the services. The utility company has experienced costs each year to repair and maintain the lines. Converting the lines to underground would remove the risk of damage from wind and winter storm.</p> <p>The Disaster Mitigation Act of 2000 requires communities to develop comprehensive actions to reduce the impacts of natural hazards, with an emphasis on new and existing buildings and infrastructure.[201.6(c)(3)(ii)] Converting primary electrical overhead lines to mountaintop communication services with underground lines will reduce the impact of severe weather on power lines, and will continue power service to rural customers as well as ODOT, State Police, county sheriff, emergency services, telephone utilities, and cell phone companies.</p>		
Ideas for Implementation:	Actions Taken Since 2015	
<p>Work with the consumer-owned electric utility providers to identify “undergrounding districts” so that they can plan for future investments in the area to be undergrounded. Utilize utility franchise fees, urban renewal funds and other resources, including grants, to underground existing overhead lines. Continue to require that utilities be undergrounded with new subdivision approvals.</p> <p>In both rural and urban areas, identify overheard power circuits particularly vulnerable to downed trees (where are power outages are likely to occur). Areas that are difficult to access by power repair crews will be considered when prioritizing these areas for undergrounding power lines.</p>	Added in 2015; Ongoing in 2021	
Coordinating Organization:	Deschutes County Emergency Services	
Internal Partners:	External Partners:	
Community Development, City Community	Electric Utilities	

Development/ Planning, and Public Works		
Potential Funding Sources:	Estimated cost:	Timeline:
Electric Utilities, FEMA PDM, landowners, Local Funding Resources		<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2015 NHMP Committee	
Action Item Status:	Ongoing	

Action Item: MULTI HAZARD #8 (What do we want to do?)		Alignment with Plan Goals:	High Priority Action Item?
Identify, inventory and prioritize hardening of critical communications infrastructure.		1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input checked="" type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input checked="" type="checkbox"/> Yes
Affected Jurisdictions:			
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Sisters <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Bend			
Alignment with Existing Plans/Policies:			
EOP, SCIP (Statewide Communication Interoperability Plan)			
Rationale for Proposed Action Item (why is it important?):			
Resilient communications infrastructure will reduce the likelihood of communication failure(s) during disasters, thus, improving public alert and warning and operational coordination.			
Ideas for Implementation (how will it get done?):		Action Status Report	
GIS analysis of communication infrastructure and hazard zones, prioritization of hardening measures and collaboration with land managers and infrastructure owners to initiate mitigation efforts		New in 2021	
Potential Funding Sources:	Estimated Cost:	Timeline:	
Local, BRIC (Building Resilient Infrastructure and Communities) Grant, private investment, other state/federal mitigation funds	TBD	<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input checked="" type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)	
Coordinating/Lead Organization:	Deschutes County Emergency Services		
Internal Partners:	External Partners:		

Deschutes County 911, Deschutes County Forester/Project Wildfire, Deschutes County Information Technology/GIS	ODOT, ODF, USFS, BLM, private landowners, private infrastructure owners
Form Submitted by:	Nathan Garibay
Action Item Status (for existing actions only):	NEW, 2021

Action Item: MULTI HAZARD #9 (What do we want to do?)		Alignment with Plan Goals:	High Priority Action Item?
Support the development and coordination of the Regional Emergency Services Training and Coordination Center (RESTCC)		1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input checked="" type="checkbox"/> 11 <input type="checkbox"/> 12 <input type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input type="checkbox"/> Yes
Affected Jurisdictions:			
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Sisters <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Bend			
Alignment with Existing Plans/Policies:			
State EOP, County EOP, State Recovery Plan			
Rationale for Proposed Action Item (why is it important?):			
<p>Central Oregon, Oregon, and the Pacific Northwest are facing growing threats from natural disasters that severely impact our households, communities, and economies – including large-scale wildfire, flooding and landslides, future pandemics and public health crises, and the Cascadia Subduction Zone.</p> <p>Central Oregon has insufficient facilities to meet existing mandatory training needs of local, state, and federal public safety personnel. In a rapidly growing region, the need for trained public safety and emergency services professionals is increasing. Furthermore, the region lacks a dedicated, multi-agency coordination center for emergency operations, nor does it have an adequate backup 911-center with redundant emergency dispatch capabilities. And in the event of a major natural disaster such as a Cascadia Subduction Zone event, Redmond and the Redmond Airport have been envisioned as a primary staging ground for statewide rescue and recovery operations.</p> <p>The RESTCC would include all the high-priority training needs and props to ensure that critical law enforcement, fire/EMS, and other emergency and preparation needs (e.g train derailment, airport emergencies, etc.) are met. The facility will also offer a turnkey Emergency Operations Center (EOC) in the event of a major regional, statewide or larger-scale disaster (e.g. Cascadia or future pandemics).</p>			
Ideas for Implementation (how will it get done?):		Action Status Report	
<ul style="list-style-type: none"> - Build a Master Plan - Initiate UGB Expansion Process - Create an MOU for regional partners - Design/Engineering - Capital funding: Phase 1 Capital = \$25-30 million 		The Strategic Business Plan for this facility was completed in September 2020, and since then COIC and partners have met to discuss the outcomes of the plan and identify next steps for this project over the coming 12-18 months. The highest priorities for the next phase of this project are securing a site, addressing land use and infrastructure issues, and completing design/engineering for the first phase.	
Potential Funding Sources:	Estimated Cost:	Timeline:	

Local, state, federal	\$100,000,000	<input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> Long (6+ years) <input type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)
Coordinating/Lead Organization:	COIC	
Internal Partners:	External Partners:	
DCSO, Board of County Commissioners, Cities, Special Service Districts	OEM, OSFM, ODF, OSP, DPSST, Governor's Office Regional Solutions, Central Oregon Fire Management Services (COFMS), Crook County, Jefferson County, Central Oregon Fire Chief's Association (COFCA), Central Oregon Law Enforcement Services (COLES)	
Form Submitted by:	Nathan Garibay	
Action Item Status (for existing actions only):	NEW, 2021	

Action Item: Earthquake #1	Alignment with Plan Goals:	High Priority Action Item?
Support development of in-depth studies to determine county and region's vulnerability to earthquake.	<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:		
Regular meetings and communication with the Oregon Resilience Plan (Cascadia Earthquake scenario). Possible opportunity to partner with OSU Cascades for research in the region.		
Rationale for Proposed Action Item:		
<p>Deschutes County is susceptible to earthquakes from four sources:</p> <p>Cascadia Subduction Zone: The Cascadia Subduction Zone (CSZ) is the boundary between the descending oceanic Juan de Fuca Plate and the overriding North American Plate. This area of contact, located off the Oregon coast, is capable of producing some of the largest earthquakes on Earth with magnitude (M) 9.0 or greater. Based on historical averages, there is a 10-15% chance that the CSZ could produce a M 9.0 earthquake in the next 50 years, and a 37% chance of a M 8.0 earthquake in the next 50 years. The effects of a CSZ earthquake would be felt most strongly along the coast and in the Willamette Valley, but strong shaking would also occur in central Oregon. All parts of Deschutes County are vulnerable to damage from a CSZ earthquake; unreinforced masonry buildings are especially vulnerable.</p> <p>Deep intraplate earthquakes: These earthquakes occur within the Juan de Fuca Plate as it descends beneath the North American Plate. They occur at depths between 30 and 100 kilometers (about 20 to 60 miles) and can approach M 7.5. Regions in Oregon most vulnerable to these earthquakes include a broad zone from the coast to the western foothills of the Cascades, but centered in the Willamette Valley. Residents of Deschutes County might feel some shaking from deep intraplate earthquakes, but the risk of damage is low.</p> <p>Shallow crustal earthquakes: These earthquakes occur on faults in the North American Plate and are associated with extension (pulling apart of the crust). They can be so shallow that they rupture or deform the ground surface, but can also occur up to 35 kilometers deep (about 20 miles) and may not be associated with faults observed at the surface. These earthquakes can reach M 7.0, causing extensive localized damage. Significant crustal earthquakes have occurred in central Oregon during historical times, but have been located in Klamath and Lake Counties. However, crustal fault zones in Klamath and Lake Counties extend into Deschutes County and all parts of Deschutes County are vulnerable to damage from these earthquakes.</p> <p>Volcanic earthquakes: Volcanic earthquakes are triggered by changes in the magmatic system below volcanoes. They are common in Deschutes County near volcanic centers in the Cascades and Newberry Volcano. These earthquakes are typically less than M 2.5 (too small to be felt) but may reach M 5.0. Swarms of volcanic earthquakes can persist for weeks to months before volcanic eruptions and often serve as precursors to an eruption. The likelihood of volcanic earthquakes occurring in Deschutes County is very high, but little to no damage is likely to occur to buildings or communities.</p>		
Ideas for Implementation:	Actions Taken Since 2015	
Work with OEM, DOGAMI, FEMA and USGS and expand existing studies to address scope of	Developed in 2015; deferred to 2026 Plan	

<p>vulnerability.</p> <p>Communicate study findings with key stakeholders affiliated with public awareness, education, policy and mitigation strategies identified in study.</p> <p>If needed, make policy and procedures changes that support study results that mitigate earthquake hazards.</p> <p>Determine the impact that an event located outside the county will have on Deschutes County including west side evacuation to central Oregon.</p>		<p>Deferred to 2020 Plan</p> <p>Deferred to 2020 Plan</p> <p>Deferred to 2020 Plan</p>	
Coordinating Organization:		Deschutes County Emergency Services	
Internal Partners:		External Partners:	
Community Development		FEMA, DOGAMI, OEM, USGS, OSU Cascades	
Potential Funding Sources:		Estimated cost:	Timeline:
Oregon State University – Cascades, OEM, Local Funding Resources			<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2010 NHMP Committee		
Action Item Status:	Deferred		

Action Item: Earthquake #2	Alignment with Plan Goals:	High Priority Action Item?
Seismically retrofit vulnerable facilities and infrastructure to increase their resiliency to seismic hazards. Consider both structural and non-structural retrofit options.	<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input checked="" type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:		
DOGAMI RVS (2007)		
Rationale for Proposed Action Item:		
<p>The 2007 Statewide Seismic Needs Assessment Study conducted by DOGAMI identified buildings with a high to very high collapse potential ratings.</p> <p>Occupants of these buildings are often school age children and are vulnerable to potential injury should an event occur.</p> <p>Oregon Senate Bill 2 (2005) directed DOGAMI to develop a statewide seismic needs assessment that includes a FEMA 154 Rapid Visual Screening survey of specific critical facilities, including schools.</p> <p>Retrofitting of vital infrastructure, such as schools, emergency service, and other community buildings, provides important improvements that reduce hazard exposure and the cost and time associated with recovery (Source: American Planning Advisory Service Report Number 483/484).</p> <p>Deschutes County has a high vulnerability for seismic hazards (related to the Cascadia Earthquake event) and a moderate probability of a future seismic event occurring. Retrofitting seismically vulnerable buildings will significantly reduce the buildings' vulnerability to seismic hazards and improve the safety of occupants (emergency personnel, students, teachers, and community members that use the buildings).</p> <p>The Disaster Mitigation Act of 2000 requires communities to identify actions and projects that reduce the effects of hazards on the community, particularly to buildings and infrastructure [201.6(c)(3)(ii)]. Identifying critical and essential facilities for seismic retrofit will help to identify major seismic issues and appropriate mitigation actions to protect critical and essential facilities.</p>		
Ideas for Implementation:	Actions Taken Since 2015	
<p>Conduct detailed structural evaluation that outlines recommendations for building deficiencies, and provides a cost estimate, incorporating DOGAMI's seismic assessment data to assist in retrofitting</p> <p>Apply for grant funding through the Oregon Seismic Rehabilitation Grant Program</p> <p>Apply for FEMA project grant funding.</p> <p>Conduct structural evaluations of critical and essential facilities (including historical buildings), and infrastructure and make recommendations (structural and non-structural) for fix. Align projects with regular maintenance programs.</p>	Developed in 2015; Ongoing in 2021	

Coordinating Organization:	Deschutes County Natural Hazards Mitigation Committee	
Internal Partners:	External Partners:	
Public Works, Community Development, Building, Fire, Police, Sheriff	Deschutes County School Districts, Oregon Military Department - Office of Emergency Management (OEM), Oregon Department of Geology and Mineral Industries (DOGAMI), Federal Emergency Management Agency (FEMA), Oregon Department of Education (ODE); Oregon Business Development Department - Infrastructure Finance Authority (IFA), State Historic Preservation Office (SHPO)	
Potential Funding Sources:	Estimated cost:	Timeline:
Seismic Rehabilitation Grants (IFA), Local Funding Resources		<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2015 NHMP Committee	
Action Item Status:	Ongoing	

Action Item: EARTHQUAKE #3 (What do we want to do?)		Alignment with Plan Goals:		High Priority Action Item?	
Develop outreach strategy and increase public awareness of ShakeAlert Early Warning System in Deschutes County.		1 <input checked="" type="checkbox"/>	2 <input type="checkbox"/>	3 <input checked="" type="checkbox"/>	4 <input checked="" type="checkbox"/>
		5 <input type="checkbox"/>	6 <input checked="" type="checkbox"/>	7 <input checked="" type="checkbox"/>	8 <input type="checkbox"/>
		9 <input type="checkbox"/>	10 <input checked="" type="checkbox"/>	11 <input type="checkbox"/>	12 <input type="checkbox"/>
			13 <input type="checkbox"/>	14 <input type="checkbox"/>	<input type="checkbox"/> Yes
Affected Jurisdictions:					
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Sisters <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Bend					
Alignment with Existing Plans/Policies:					
Cascadia Playbook, EOP					
Rationale for Proposed Action Item (why is it important?):					
Public outreach to spread awareness of WEA Shakealert messaging; appropriate actions will reduce injuries/casualties, and outreach campaign will prepare individuals/businesses for impacts of large-scale earthquake					
Ideas for Implementation (how will it get done?):			Action Status Report		
Social and traditional media campaign to utilize Facebook, Instagram, Twitter, NextDoor, and media partners. Incorporation of ShakeAlert within existing preparedness programs/initiatives.			New in 2021		
Potential Funding Sources:		Estimated Cost:	Timeline:		
Local		LOW	<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input type="checkbox"/> Medium (2-5 years) <input checked="" type="checkbox"/> Short (0-2 years)		
Coordinating/Lead Organization:		Deschutes County Sheriff's Office (Emergency Services)			
Internal Partners:			External Partners:		
Deschutes County Health Services, Deschutes County Board of County Commissioners (Communications), Deschutes County 911, incorporated cities & fire districts			OEM, DOGAMI, USGS,		

Form Submitted by:	Nathan Garibay
Action Item Status (for existing actions only):	NEW, 2021

Action Item: Flood #1		Alignment with Plan Goals:				High Priority Action Item?
Continue to coordinate mitigation activities with appropriate agencies and home and business owners/groups that include an inventory of actions to or within the floodplain.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Affected Jurisdictions:						
<input checked="" type="checkbox"/> Deschutes County		<input checked="" type="checkbox"/> Bend		<input type="checkbox"/> Redmond		
		<input checked="" type="checkbox"/> La Pine		<input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:						
Comprehensive Plan, FEMA Flood Insurance Study, Flood Insurance Rate Maps						
Rationale for Proposed Action Item:						
Any mitigation activity within the floodplain will impact multiple stakeholders including property owners and State and Federal agencies dealing with water usage, recreation, wetlands, and wildlife habitat issues. Coordination of mitigation activities will ensure that any planned activities obtain required permits, meet the requirements and goals of relevant agencies.						
Ideas for Implementation:				Actions Taken Since 2015		
Establish protocol to regularly update mitigation actions and activities within the floodplain.				Developed in 2010; Ongoing in 2015; Ongoing in 2021		
Coordinating Organization:		Deschutes County Community Development				
Internal Partners:			External Partners:			
Emergency Services, Public Works, Building Division			Oregon Water Resources, DLCD, , USGS, Bureau of Reclamation, Oregon Department of State Lands, Army Corps of Engineers, Oregon Department of Fish and Wildlife, US Forest Service,			
Potential Funding Sources:			Estimated cost:		Timeline:	
Planning application fees cover stakeholder coordinations, other Local Funding Resources					<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing	
Form Submitted by:		2010 NHMP Committee				
Action Item Status:		Ongoing				

Action Item: Flood #2		Alignment with Plan Goals:	High Priority Action Item?
Maintain an inventory of all permitted in-water facilities in Deschutes County.		<input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:			
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input type="checkbox"/> Redmond <input type="checkbox"/> La Pine <input type="checkbox"/> Sisters			
Alignment with Existing Plans/Policies:			
Rationale for Proposed Action Item:			
Craine Prairie Reservoir, Wickiup Reservoir, area canals that are above residential areas are chief concerns			
Ideas for Implementation:		Actions Taken Since 2010	
Update appropriate seismic criteria and procedures for evaluating performance of existing dams.		Developed in 2010; Deferred in 2015; Deferred in 2021 to 2026 Plan	
Coordinating Organization:	Deschutes County Community Development		
Internal Partners:		External Partners:	
Emergency Services		Oregon Water Resources, USGS, Bureau of Reclamation	
Potential Funding Sources:		Estimated cost:	Timeline:
Local Funding Resources, Americorps/ RARE			<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2010 NHMP Committee		
Action Item Status:	Deferred		

Action Item: Flood #3	Alignment with Plan Goals:	High Priority Action Item?
Comply with National Flood Insurance Program to maintain participation in program.	<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input checked="" type="checkbox"/> 7 <input checked="" type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:		
Comprehensive Plan, FEMA Flood Insurance Study, Flood Insurance Rate Maps		
Rationale for Proposed Action Item:		
<p>Compliance with the NFIP is a prerequisite for County residents to receive flood insurance.</p> <p>The County currently includes about 170 flood insurance policies; roughly half of these are preferred risk policies (PRP). PRPs are not eligible to receive CRS Premium Discounts. Additionally, the county has a flood insurance market penetration of approximately 15% (as of 2012).</p> <p>Increasing flood insurance coverage will allow the county to reduce vulnerability, and facilitate recovery.</p>		
Ideas for Implementation:	Actions Taken Since 2015	
<p>Local Floodplain Manager to work with the State Floodplain Manager at DLCD (and federal NFIP liaison, as necessary) to identify any additional actions needed to maintain NFIP compliance including assessment of staff resources, need for Community Assistance Visits, and integration of updated Regulations.</p> <p>Work with DLCD to better identify and map floodplains.</p> <p>Work with DLCD to offer community education and outreach.</p> <p>Outreach to property owners with residences in the special flood hazard area and offer education about the benefits of purchasing flood insurance.</p> <p>Work with DLCD on any issues that arise from NFIP implementation monitoring activities.</p> <p>Track all community assistance, education and monitoring activities.</p> <p>Participate in and implement the Community Rating System as part of the NFIP.</p>	Developed in 2015; Ongoing in 2015; Ongoing in 2021	
Coordinating Organization:	Deschutes County Community Development	
Internal Partners:	External Partners:	

		DLCD, FEMA	
Potential Funding Sources:		Estimated cost:	Timeline:
Local Funding Resources/ County Floodplain Manager/ DLCD			<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	2010 NHMP Committee		
Action Item Status:	Ongoing		

Action Item: Flood #4		Alignment with Plan Goals:	High Priority Action Item?
Update the Flood Insurance Rate Maps for Deschutes County and revisit land use codes to determine if floodplain standards are still adequate.		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input checked="" type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input checked="" type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:			
<input checked="" type="checkbox"/> Deschutes County		<input checked="" type="checkbox"/> Bend	<input type="checkbox"/> Redmond
		<input checked="" type="checkbox"/> La Pine	<input checked="" type="checkbox"/> Sisters
Alignment with Existing Plans/Policies:			
Comprehensive Plan, FEMA Flood Insurance Study, Flood Insurance Rate Maps			
Rationale for Proposed Action Item:			
<p>Areas of concern, listed below, are presently not mapped as areas of special flood hazard. In addition, current flood insurance rate maps (FIRMs) may be significantly enhanced by use of existing LiDAR data and an evaluation of reduced channel capacity in the Deschutes River due to sediment accumulation.</p> <p>Areas of concern: Indian Ford (west of Sisters), Trout Creek (Sisters), Whychus Creek drainage, Tumalo Creek, Little Deschutes River (La Pine area), Deschutes River (from Wickiup through the Tumalo area at certain points).</p>			
Ideas for Implementation:		Actions Taken Since 2015	
Work with appropriate agencies to update Flood Insurance Rate Maps. Revisit and update land use codes to determine if floodplain standards are adequate.		Developed in 2010; Ongoing in 2015; Ongoing in 2021	
Coordinating Organization:		Deschutes County Community Development	
Internal Partners:		External Partners:	
		FEMA, DOGAMI, DLCD	
Potential Funding Sources:		Estimated cost:	Timeline:
DLCD, Risk MAP Funding Consideration, Local Funding Resources			<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2010 NHMP Committee		
Action Item Status:	Ongoing		

Action Item: Flood #5		Alignment with Plan Goals:			High Priority Action Item?	
As funding becomes available, implement mitigation measures for individual properties adjacent to or within the floodplain as appropriate.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input checked="" type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input checked="" type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Affected Jurisdictions:						
<input checked="" type="checkbox"/> Deschutes County		<input checked="" type="checkbox"/> Bend		<input type="checkbox"/> Redmond		
		<input checked="" type="checkbox"/> La Pine		<input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:						
Comprehensive Plan, FEMA Flood Insurance Study, Flood Insurance Rate Maps						
Rationale for Proposed Action Item:						
<p>Although the county does not currently have repetitive flood loss properties, or severe repetitive flood loss properties, there are properties within the special flood hazard area that are vulnerable to flood.</p> <p>Areas of concern, listed below, are presently not mapped as areas of special flood hazard. In addition, current flood insurance rate maps (FIRMs) may be significantly enhanced by use of existing LiDAR data and an evaluation of reduced channel capacity in the Deschutes River due to sediment accumulation.</p> <p>Areas of concern: Indian Ford (west of Sisters), Trout Creek (Sisters), Whychus Creek drainage, Tumalo Creek, Little Deschutes River (La Pine area), Deschutes River (from Wickiup through the Tumalo area at certain points).</p>						
Ideas for Implementation:			Actions Taken Since 2015			
<p>Assess individual properties for possible mitigation measures (elevation, acquisition, relocation) to reduce or prevent future flood losses.</p> <p>Implement mitigation measures (elevation, acquisition, relocation) for properties within the floodplain.</p>			Developed in 2010; Deferred in 2015; Ongoing in 2021			
Coordinating Organization:		Deschutes County Community Development				
Internal Partners:			External Partners:			
			FEMA, DOGAMI, DLCD			
Potential Funding Sources:			Estimated cost:		Timeline:	
FEMA Flood Mitigation Assistance Project Grants; Local Funding Resources					<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing	
Form Submitted by:		2010 NHMP Committee				
Action Item Status:		Ongoing				

Action Item: Flood #6		Alignment with Plan Goals:	High Priority Action Item?
Analyze and implement mitigation measures related to ice jamming that occurs during winter storm events.		<input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input checked="" type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:			
<input checked="" type="checkbox"/> Deschutes County		<input checked="" type="checkbox"/> Bend	<input type="checkbox"/> Redmond
		<input type="checkbox"/> La Pine	<input type="checkbox"/> Sisters
Alignment with Existing Plans/Policies:			
Comprehensive Plan, FEMA Flood Insurance Study, Flood Insurance Rate Maps			
Rationale for Proposed Action Item:			
Ice jams on the Deschutes and Little Deschutes rivers have created flood conditions in the past and will continue to do so due to local topography. Ice jams commonly happen during the winter and early spring, while the river is still frozen. Sudden warming at higher altitudes can melt waters resulting in increased runoff of water and ice into large reaches of frozen river below. On the way downstream, the ice can “jam” in narrow places on the river or against a road crossing, effectively damming the river, sometimes followed by a sudden breach and release of the water and ice.			
Ideas for Implementation:		Actions Taken Since 2015	
		Added in 2015; Deferred in 2021	
Coordinating Organization:	Deschutes County Emergency Services/ Planning		
Internal Partners:		External Partners:	
Public Works, Bend Parks and Recreation District		Oregon Water Resources, Pacific Power, Landowners, DLCD, DOGAMI	
Potential Funding Sources:		Estimated cost:	Timeline:
USACE Silver Jackets Program, OWEB, DSL; Local Funding Resources			<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2015 NHMP Committee		
Action Item Status:	Deferred		

Action Item: Flood #7	Alignment with Plan Goals:	High Priority Action Item?
Re-evaluate debris flow and flood hazards along Whychus Creek from moraine-dammed Carver Lake. Depending on outcome of study, consider suitable mitigative measures in City of Sisters and Deschutes County.	<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input checked="" type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input type="checkbox"/> Bend <input type="checkbox"/> Redmond <input type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:		
Results of a 1987 USGS report (Hydrologic Hazards Along Squaw [Whychus] Creek from a Hypothetical Failure of the Glacial Moraine Impounding Carver Lake near Sisters, Oregon; USGS, Open File Report 87-41) were incorporated into the 2007 FEMA Flood Insurance Rate Map for Deschutes County (FIRM, Panel 0245E). USGS scientists consider the 1987 assessment in need of re-evaluation in light of new research results on past such events at Central Oregon moraine-dammed lakes and refined flood models that are now available.		
Rationale for Proposed Action Item:		
<p>Carver Lake, located at 7,800 feet on the east slope of South Sister volcano, contains about 740 acre-feet (900,000 cubic meters or 32 million cubic feet) of water. The lake is dammed by a glacial moraine formed chiefly during late 19th and early 20th centuries. Several other such moraine-dammed lakes in Central Oregon have experienced rapid outflows during the past 80 years that resulted in debris flows and floods along streams draining the lakes. Carver Lake and its outlet stream, a tributary to Whychus Creek, are susceptible to similar debris flows and floods in the future. The extent and magnitude of such flows will depend on several factors, including amount of water released, rate of release, and conditions along the flow path.</p> <p>A 1987 USGS report concluded that the annual probability of a flood from failure of the moraine dam of Carver Lake is 1 to 5 percent and that the magnitude of the worst-case flow could be ten times that of the 1-percent probability flood (100-year flood). Sisters would see rising flood waters 1.8 hours after a dam breach and the flood would peak about 30 minutes later. See P. 26 of report for a map of high and low risk areas.</p> <p>If an event of this magnitude happened, locally high velocities, damming, erosion, and sediment deposition could cause considerable property damage and possible loss of life in Sisters.</p> <p>Later research has questioned some aspects of the 1987 report. A report published in 2001 (USGS Professional Paper 1606, Debris flows from failures of neoglacial-age moraine dams in the Three Sisters and Mount Jefferson Wilderness Areas; http://pubs.er.usgs.gov/publication/pp1606) sheds new light on past events and outlook for future events. Among its findings:</p> <ol style="list-style-type: none"> 1. Since early 1920s, at least 11 (now 12 with 2012 event at Three-Fingered Jack) rapid water releases resulted from partial or total breaching of moraine dams. 2. Partial breaches amounting to lake lowering of a few feet to a few tens of feet were halted as large boulders armored outlets and downcutting ceased. 3. All partial and complete breaches formed debris flows, the farthest reaching about 6 miles from lake; sediment-laden floods and streamflow continued tens of miles farther. 4. Probability of future events depends on such factors as likelihood of rock and ice avalanches reaching the lake and generating waves that rapidly erode outlets. If Prouty Glacier continues to thin and retreat, the likelihood of ice avalanches into the lake diminishes; the opposite would be true if Prouty Glacier undergoes a period of substantial thickening and advance. 		

5. Worst-case scenarios can be defined, but the likelihood of such worst-case events may be vanishingly small.

Such findings suggest that the 1987 report overstated greatly the degree of hazard and the probability of flows causing catastrophic impacts in Sisters.

Ideas for Implementation:		Actions Taken Since 2015	
<p>USGS proposes to apply findings from the 2001 study and other applicable studies to define realistic scenarios for partial and complete breaching of the Carver lake moraine dam and evolution of debris flows and floods down Whychus Creek.</p> <p>These scenarios can be combined with modern flood-routing models and recently obtained detailed, accurate, lidar digital-elevation models, to provide refined estimates of potential for flood inundation in the low-relief fan area around the City of Sisters.</p> <p>On the basis of results of this study, Sisters and Deschutes County would be able to develop suitable mitigative measures, which could include, real time stream monitoring detection, early warning sirens, zoning, and planning studies to help prevent loss of life and property damage in the area downstream of the lake.</p>		<p>Added in 2015; Ongoing in 2021</p>	
Coordinating Organization:		Deschutes County Emergency Services	
Internal Partners:		External Partners:	
Sisters, Community Development, Public Works		USGS, USACE, FEMA, DOGAMI, OEM, OSU Cascades	
Potential Funding Sources:		Estimated cost:	Timeline:
USACE Silver Jackets Program; Local Funding Resources			<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2015 NHMP Committee		
Action Item Status:	Ongoing		

Action Item: Volcano #1	Alignment with Plan Goals:	High Priority Action Item?
Continue to support on-going study of probability of volcanic eruption and potential impact.	<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input checked="" type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input type="checkbox"/> Bend <input type="checkbox"/> Redmond <input type="checkbox"/> La Pine <input type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:		
Central Cascades Volcano Coordination Plan (2007) to be updated in 2015, local response plans, National Response Plan, Oregon State Emergency Management Plan		
Rationale for Proposed Action Item:		
<p>Volcanic activity could occur anywhere in Deschutes County. Eruptions are more likely to occur near volcanic centers in the Cascades and Newberry Volcano, but lava flows and ash deposits from vents located in these areas could reach all parts of the county.</p> <p>Lava flows: Future eruptions from the north flank of Newberry Volcano represent the most credible lava-flow threat to large settled areas in the United States outside of Hawai'i. Lava flows move relatively slowly and rarely threaten human life, but advancing flows ensure almost total destruction of property and infrastructure from burial and incineration. Lava flows also pose flooding hazards by damming waterways, which can initially trigger flooding upstream and later downstream if the lava dam fails. Lava flows can also initiate multiple forest fires, especially if they occur during dry months.</p> <p>Ash: Due to prevailing westerly winds, areas east of the Cascades have the greatest probability of being affected by ash from future eruptions anywhere in the Cascades. Volcanic ash limits visibility and, if wet, creates slippery road conditions. It is electrically conductive and abrasive, and can severely affect electrical and mechanical systems and is extremely dangerous to aircraft. Ash and other volcanic products can add large quantities of sediment to rivers and streams. This can initiate periods of years to decades during which waterways carry increased sediments loads and river channels become unstable and migrate. Such effects propagate downstream and can disrupt channels and flood plains far from where the actual eruption occurred. In particular, the Tumalo Creek watershed that supplies part of Bend's municipal water is likely to receive ash from any eruption in the Three Sisters area.</p> <p>Fields of mafic volcanoes: Hundreds of geologically young mafic volcanoes composed of cinders, ash, and lava flows dot the central Oregon landscape. Future eruptions of mafic volcanoes are possible anywhere in the central Cascades region, which includes large parts of Deschutes County. These eruptions could last for months to years or decades, producing ash and lava flows that periodically impact developed areas of Deschutes County.</p>		
Ideas for Implementation:	Actions Taken Since 2015	
<p>Continue to partner with federal and state organizations supporting studies and monitoring volcanic eruption indicators and activities.</p> <p>Participate in updating interagency communication plan for central Oregon volcanic activity.</p>	Developed in 2010; Ongoing in 2015; Deferred in 2021	
Coordinating Organization:	Deschutes County Emergency Services	

Internal Partners:		External Partners:	
Health Department		CVO (USGS Cascades Volcano Observatory), FEMA, DOGAMI, OEM, USGS, OSU Cascades	
Potential Funding Sources:		Estimated cost:	Timeline:
OSU Cascades, USGS; Local Funding Resources			<input type="checkbox"/> Short Term (1-2 years) <input checked="" type="checkbox"/> Long Term (3-5 years) <input type="checkbox"/> Ongoing
Form Submitted by:	2010 NHMP Committee		
Action Item Status:	Deferred		

Action Item: Wildfire #1		Alignment with Plan Goals:	High Priority Action Item?
Expand public information/education initiatives in support of active hazardous fuels treatment.		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input checked="" type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input checked="" type="checkbox"/> Yes
Affected Jurisdictions:			
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters			
Alignment with Existing Plans/Policies:			
Upper Deschutes River Coalition CWPP, Greater La Pine CWPP, Sunriver CWPP, Greater Sisters Country CWPP, East and West Deschutes County CWPP, Greater Bend CWP, Greater Redmond CWPP			
Rationale for Proposed Action Item:			
Ideas for Implementation:		Actions Taken Since 2015	
<p>Explore opportunities to expand the Project Wildfire mission addressing public awareness strategies.</p> <p>Expand school enrichment education about fuels reduction and wildland fire prevention near home sites.</p>		<p>Ongoing - Project Wildfire maintains regular public awareness and education programs - websites, FireFree, CWPPs, public education. Completed. Will continue.</p>	
Coordinating Organization:	Deschutes County Forester/ Project Wildfire		
Internal Partners:		External Partners:	
Emergency Services, County Forester		Firewise Communities, USFS, BLM, ODF, DEQ,	
Potential Funding Sources:		Estimated cost:	Timeline:
Obtain education funding through federal and state grants; Local Funding Resources			<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	2010 NHMP Committee		
Action Item Status:	Ongoing		

Action Item: Wildfire #2		Alignment with Plan Goals:				High Priority Action Item?
Review and upgrade existing building and land use codes to address landscape, fuel amounts and structure detail that reduces the incidence or spread of wildland fire in urban/rural interface areas.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input checked="" type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7	<input checked="" type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input type="checkbox"/> 10	<input type="checkbox"/> 11		
Affected Jurisdictions:						
<input checked="" type="checkbox"/> Deschutes County		<input checked="" type="checkbox"/> Bend		<input checked="" type="checkbox"/> Redmond		
		<input checked="" type="checkbox"/> La Pine		<input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:						
City and County Comprehensive Plans/ Development Codes						
Rationale for Proposed Action Item:						
Ideas for Implementation:			Actions Taken Since 2010			
Develop systems to regulate landscape, fuels and structure components for new construction. Develop and adopt countywide defensible space standards. Develop countywide classification system consistent with SB 360 to educate individual property owners and encourage compliance with defensible space standards.			Ongoing - This is currently being considered by the BOCC, possible decisions pending Spring 2021			
Coordinating Organization:		Deschutes County Community Development and County Forester				
Internal Partners:			External Partners:			
Community Development, County Forester, Emergency Services, Project Wildfire			ODF,			
Potential Funding Sources:			Estimated cost:		Timeline:	
Funding will be necessary to notify/educate property owners of their classification and recommended standards for defensible space. Obtain grant funding from federal and state programs, Local Funding Resources, OEM (Public awareness)					<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing	
Form Submitted by:		2010 NHMP Committee				
Action Item Status:		Ongoing				

Action Item: Wildfire #3		Alignment with Plan Goals:	High Priority Action Item?
Continue to prioritize and support fuels reduction projects on private lands utilizing FireFree and other programs; and identify and prioritize fuels reduction projects on public lands in the WUI.		<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input checked="" type="checkbox"/> 7 <input checked="" type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input checked="" type="checkbox"/> Yes
Affected Jurisdictions:			
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters			
Alignment with Existing Plans/Policies:			
County CWPPs, City and County Comprehensive Plans			
Rationale for Proposed Action Item:			
Ideas for Implementation:		Actions Taken Since 2015	
Provide opportunities for defensible space and fuels reduction through FireFree and Sweat Equity Programs. Continue to revisit CWPPs annually and update priorities for fuels reduction projects on private and public lands. Biomass accumulation reduction		Ongoing - Annually provide opportunities for homeowner participation in fuels reduction projects and FireFree projects. Annually revisit each CWPP. Conduct new risk assessments and revise priorities on a three year rotation. Maintain partnership and participation in Deschutes Forest Collaborative Project, Joint Chiefs, etc. to accomplish fuels reduction on public lands.	
Coordinating Organization:	Project Wildfire		
Internal Partners:		External Partners:	
Community Development, County Forester, Emergency Services, Project Wildfire		Firewise Communities, ODF	
Potential Funding Sources:		Estimated cost:	Timeline:
Obtain grants and cost share agreements with landowners to participate in Sweat Equity fuels reduction programs. Partner with collaborators to fund FireFree recycling days.			<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing

Form Submitted by:	2010 NHMP Committee
Action Item Status:	Ongoing

Action Item: Wildfire #4 (What do we want to do?)	Alignment with Plan Goals:	High Priority Action Item?
Assess critical infrastructure resilience to wildfire	1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input checked="" type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <input checked="" type="checkbox"/> 13 <input type="checkbox"/> 14 <input type="checkbox"/>	<input checked="" type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Sisters <input type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Bend		
Alignment with Existing Plans/Policies:		
<p>See 2015 Deschutes County NHMP:</p> <ul style="list-style-type: none"> Goal 2 <i>Minimize public and private property damages and the disruption of essential infrastructure and services from natural hazards</i> <p>See March 17, 2020 Bend City Council adopted the Council’s goals for biennium FY ’21-’23.</p> <p>Goal: Environment & Climate Improve quality of life for more people in Bend by increasing equitable access to clear air, water and to a healthy environment. Implement solutions that fulfill the City’s commitment to being good stewards of our natural environment, decreasing carbon emissions and mitigating the effects of climate change.</p> <p><u>Strategy:</u> Preserve Bend’s natural environment, including clean air and water, wildlife and trees, through partnerships and policy</p> <ul style="list-style-type: none"> Protect critical water resources and other essential city facilities with a focus on sustainability and resiliency <p><u>Strategy:</u> Create wildfire and emergency resiliency plans that acknowledge our changing climate</p>		
Rationale for Proposed Action Item (why is it important?):		
<p>The Cities of Bend, Redmond, Sisters, and La Pine all rely on water and wastewater facilities located outside of their respective urban growth boundaries (UGBs). Bend, La Pine, and Sisters have critical infrastructure facilities located near or surrounded by forest lands. It is critical to assess whether this infrastructure is resilient to wildfire given high fire risk and the consequences of water and wastewater treatment facilities failing or going offline in the event of a catastrophic wildfire. This assessment needs to evaluate risk, potential barriers or defenses against encroaching wildfire, potential infrastructure improvement to continue operations. This action items is important because current plans, e.g. the 2015 NHMP and Community Wildfire Protection Plans (CWPP), put more of an emphasis on mitigating risk of wildfire around communities, structures, and neighborhoods. This action item is needed to add focus to critical infrastructure that is also located in areas subject to wildfires.</p>		

Ideas for Implementation (how will it get done?):		Action Status Report
<p>Assess risk of wildfire for each water and wastewater facility (e.g. forest or brush/ground wildfire)</p> <p>Identify potential barriers/defenses against wildfire (e.g. irrigated pasture, concrete buildings/barriers)</p> <p>Identify actions to take to ensure facility can operate during wildfire event or has minimal offline time (backup systems, backup power)</p>		New in 2021
Potential Funding Sources:	Estimated Cost:	Timeline:
<p>Local (City) capital improvement programs (CIPs)</p> <p>State Funding wildfire resilience</p> <p>FEMA</p>	High	<input type="checkbox"/> Ongoing <input type="checkbox"/> Long (6+ years) <input checked="" type="checkbox"/> Medium (2-5 years) <input type="checkbox"/> Short (0-2 years)
Coordinating/Lead Organization:	Deschutes County/State OEM	
Internal Partners:	External Partners:	
<p>City of Bend</p> <p>City of Sisters</p> <p>City of La Pine</p> <p>Deschutes County</p>	<p>State OEM</p> <p>State DLCDC – wildfire resilience</p>	
Form Submitted by:	Damian Syrnyk, City of Bend	
Action Item Status (for existing actions only):	NEW, 2021	

Action Item: Winter Storm #1		Alignment with Plan Goals:			High Priority Action Item?	
Continue to coordinate mitigation activities to reduce risk to the public from severe winter storms.		<input checked="" type="checkbox"/> 1	<input checked="" type="checkbox"/> 2	<input checked="" type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> Yes
		<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input checked="" type="checkbox"/> 7	<input type="checkbox"/> 8	
		<input type="checkbox"/> 9	<input checked="" type="checkbox"/> 10	<input type="checkbox"/> 11		
Affected Jurisdictions:						
<input checked="" type="checkbox"/> Deschutes County		<input checked="" type="checkbox"/> Bend		<input checked="" type="checkbox"/> Redmond		
		<input checked="" type="checkbox"/> La Pine		<input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:						
County and City Emergency Operations Plans						
Rationale for Proposed Action Item:						
Deschutes County is subject to severe winter storms. Although most residents are generally prepared for extreme and prolonged winter events can affect our population. These events can prevent access to healthcare, medications, food, and can interfere with residents' ability to heat their homes.						
Ideas for Implementation:			Actions Taken Since 2015			
Continue and expand partnerships with county, city, homeowner groups, businesses and other organizations on strategies that mitigate impact of snow, cold weather, ice and other events related to severe winter storms. Provide training for setting-up/ operating Emergency Operations Center (EOC) and using Incident Command System (ICS)			Developed in 2010; Ongoing in 2015; Ongoing in 2021			
Coordinating Organization:		Deschutes County Emergency Services				
Internal Partners:			External Partners:			
City and County Public Works, Public Health			Utility companies, Vulnerable Populations Work Group, American Red Cross, other Community Organizations Active in Disasters.			
Potential Funding Sources:			Estimated cost:		Timeline:	
Pursue grant and budgetary funding for educational outreach and partnership development, Local Funding Resources					<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing	
Form Submitted by:		2010 NHMP Committee				
Action Item Status:		Ongoing				

Action Item: Winter Storm #2	Alignment with Plan Goals:	High Priority Action Item?
Continue public awareness of severe winter storm mitigation activities.	<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input checked="" type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:		
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters		
Alignment with Existing Plans/Policies:		
County and City Emergency Operations Plans		
Rationale for Proposed Action Item:		
Deschutes County is subject to severe winter storms. Although most residents are generally prepared for extreme and prolonged winter events can affect our population. These events can prevent access to healthcare, medications, food, and can interfere with residents' ability to heat their homes.		
Ideas for Implementation:	Actions Taken Since 2015	
<p>Target new residents and businesses; continue coordination and expansion of public awareness system providing education about protecting life, property, and the environment from severe winter storm events.</p> <p>Distribute educational information about alternative heating sources, equipment and supplies to use during severe winter storm and power outage.</p> <p>Develop coordinated utility restoration plans with all utility sources.</p> <p>Develop coordinated plan for housing large numbers of residents and tourists.</p> <p>Develop Coordinated Plan for Outreach to Vulnerable Populations</p>	Developed in 2010; Ongoing in 2015; Ongoing in 2021	
Coordinating Organization:	Deschutes County Emergency Services	
Internal Partners:	External Partners:	
City and County Public Works, Public Health	Vulnerable Populations Work Group, American Red Cross	
Potential Funding Sources:	Estimated cost:	Timeline:
County and Cities, Pursue grant funding for educational materials and distribution, Coordinate with OEM (Public awareness), Local Funding Resources		<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing

Form Submitted by:	2010 NHMP Committee
Action Item Status:	Ongoing

Action Item: Winter Storm #3		Alignment with Plan Goals:	High Priority Action Item?
Continue to enhance coordination maintenance and mitigation activities to reduce risk to public infrastructure from severe winter storms.		<input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input checked="" type="checkbox"/> 10 <input type="checkbox"/> 11	<input type="checkbox"/> Yes
Affected Jurisdictions:			
<input checked="" type="checkbox"/> Deschutes County <input checked="" type="checkbox"/> Bend <input checked="" type="checkbox"/> Redmond <input checked="" type="checkbox"/> La Pine <input checked="" type="checkbox"/> Sisters			
Alignment with Existing Plans/Policies:			
County and City Emergency Operations Plans			
Rationale for Proposed Action Item:			
Deschutes County is subject to severe winter storms. Although most residents are generally prepared for extreme and prolonged winter events can affect our population. These events can prevent access to healthcare, medications, food, and can interfere with residents' ability to heat their homes.			
Ideas for Implementation:		Actions Taken Since 2015	
Annually meet with county and city departments responsible for maintaining infrastructures including those addressing emergencies, roads, sewers, water etc. to address upgrades and improvements needed and needs of new and emerging neighborhoods.		Developed in 2010; Ongoing in 2015; Ongoing in 2021	
Coordinating Organization:	Deschutes County Emergency Services		
Internal Partners:		External Partners:	
City and County Public Works, Public Health		Utilities, Vulnerable Populations Work Group, American Red Cross	
Potential Funding Sources:		Estimated cost:	Timeline:
With department budgets at an all-time low, departmental funding is unlikely in the next five years. Pursue grant funding for educational materials and distribution. Coordinate with OEM (Public awareness), Local Funding Resources			<input type="checkbox"/> Short Term (1-2 years) <input type="checkbox"/> Long Term (3-5 years) <input checked="" type="checkbox"/> Ongoing
Form Submitted by:	2010 NHMP Committee		
Action Item Status:	Ongoing		

APPENDIX B: PLANNING AND PUBLIC PROCESS

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Tables and Figures

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Memo

To: Federal Emergency Management Agency
From: Central Oregon Intergovernmental Council
Date: June 18, 2021
Re: List of changes to the 2015 Deschutes County NHMP for the 2021 Plan Update

Purpose

This memo describes the changes made to the 2015 Deschutes County Natural Hazards Mitigation Plan (NHMP) during the 2021 plan update process. Major changes are documented by plan section in table B-1 below.

Project Background

Deschutes County partnered with the Central Oregon Intergovernmental Council (COIC) to update the 2015 Deschutes County Natural Hazards Mitigation Plan (NHMP). The Disaster Mitigation Act of 2000 requires communities to update their mitigation plans every five years to remain eligible for Pre-Disaster Mitigation (PDM) program funding, Flood Mitigation Assistance (FMA) program funding, and Hazard Grant Mitigation Program (HMGP) funding. COIC met with members of the Deschutes County steering committee in December, January, February, and March to update portions of the county's NHMP. During this update cycle the cities of Bend, La Pine, Redmond, and Sisters opted to participate; as such the 2021 plan is multi-jurisdictional. Formal meetings with the steering committees for the four participating cities occurred during April 2021. All meetings were held virtually via Zoom given local, regional, and state COVID-19 guidelines and restrictions. COIC and the committees made several changes to the 2015 NHMP. Major changes are documented and summarized in this memo.

2021 Plan Update Changes

The sections below only discuss *major* changes made to the 2015 Deschutes County NHMP during the 2021 plan update process. Major changes include the replacement or deletion of large portions of text, changes to the plan's organization, and new, updated, or removed mitigation action items. If a section is not addressed in this memo, then it can be assumed that no significant changes occurred.

The plan's format and organization were altered to fit within Oregon Partnership for Disaster Resilience's plan templates in 2015. The steering committee opted to continue using this template and format in 2021.

Table B-I Significant Changes from 2015 to 2021

Deschutes County Multi-jurisdictional NHMP Sections	Significant Updates in 2021
Acknowledgements	Steering committee and partner lists updated with 2021 participants Replaced OPDR information with COIC
Approval Letters and Resolutions	Approval letters for 2021 included
Table of Contents	N/A
Volume I: Basic Plan	
Executive Summary	Participants list updated with 2021 steering committee representation Risk assessment summary table updated with 2021 scores Mitigation plan mission and goals updated with 2021 steering committee mission and goals Plan adoption dates updated for 2021
Section 1: Introduction	How the plan was developed was updated to reflect the 2021 process
Section 2: Risk Assessment	Hazard identification table to include 2020 State of Oregon NHMP identified hazards for Region 6 Extreme heat omitted justification Federal disaster declarations added through 2021 Updated community vulnerabilities and data Updated flood insurance detail table through April 2021 Vulnerability and probability ratings updated with 2021 scores Hazard analysis matrix updated with 2021 scores
Section 3: Mitigation Strategy	Steering committee updated mission and goals Four new action items were developed and included (MH#8, MH#9, EQ#3, and WF#4), and one existing was updated for clarity (MH#4) All existing action items were given a status update Priority action items were identified and agreed upon Action item worksheets explanation was updated to reflect 2021 worksheets Action item process updated to include 2021 process
Section 4: Plan Implementation and Maintenance	Members coordinating body list updated to reflect 2021 committee Deschutes county bi-annual update meeting schedule now includes two cities per meeting Public involvement process updated to reflect 2021 process
Volume II: Hazard Annexes	
Drought	See "significant changes" box at beginning of section
Earthquake	See "significant changes" box at beginning of section
Flood	See "significant changes" box at beginning of section
Landslide	See "significant changes" box at beginning of section

Volcano	See "significant changes" box at beginning of section
Wildfire	See "significant changes" box at beginning of section
Windstorm	See "significant changes" box at beginning of section
Winter Storm	See "significant changes" box at beginning of section
Volume III: Jurisdictional Addenda	
City of Bend	<p>How the plan was developed was updated to include 2021 process</p> <p>One new action item was developed (WF#5) and all existing action items were updated with new project leads</p> <p>A status updated was provided for all existing action items</p> <p>The implementation process was updated to reflect the new county 2021 schedule</p> <p>A tribal land acknowledgement statement was added to the Community Profile and Asset Identification section</p> <p>The existing plans list was updated</p> <p>Community asset lists and tables were updated</p> <p>The Hazard Analysis Matrix and the vulnerability and probability comparisons with the county's ratings were updated to reflect 2021 scores and ratings</p> <p>Each hazard description includes at least one update to reflect new understanding of risks and vulnerabilities in 2021</p> <p>All hazard ratings were updated within the hazard narratives to reflect 2021 ratings</p> <p>The mitigation plan mission and goals were updated to reflect adoption of the 2021 county mission and goals</p> <p>Action item forms were updated to reflect status changes and a new action item form was added for WF#5</p>
City of La Pine	<p>How the plan was developed was updated to include 2021 process</p> <p>Action item WS#1 was revised to MH#1, and the 2015 WF#1 action was removed and replaced with a new action item (WF#1)</p> <p>A status updated was provided for all existing action items</p> <p>The implementation process was updated to reflect the new county 2021 schedule</p> <p>A tribal land acknowledgement statement was added to the Community Profile and Asset Identification section</p> <p>The existing plans list was updated</p> <p>Community asset lists and tables were updated</p> <p>The Hazard Analysis Matrix and the vulnerability and probability comparisons with the county's ratings were updated to reflect 2021 scores and ratings</p> <p>Each hazard description includes at least one update to reflect new understanding of risks and vulnerabilities in 2021</p> <p>All hazard ratings were updated within the hazard narratives to reflect 2021 ratings</p> <p>The mitigation plan mission and goals were updated to reflect adoption of the 2021 county mission and goals</p> <p>Action item forms were updated to reflect status changes and a new action item form was added for WF#1</p>

<p>City of Redmond</p>	<p>How the plan was developed was updated to include 2021 process A status updated was provided for all existing action items One action item was removed (FL#1) The implementation process was updated to reflect the new county 2021 schedule A tribal land acknowledgement statement was added to the Community Profile and Asset Identification section The existing plans list was updated Community asset lists and tables were updated The Hazard Analysis Matrix and the vulnerability and probability comparisons with the county's ratings were updated to reflect 2021 scores and ratings Each hazard description includes at least one update to reflect new understanding of risks and vulnerabilities in 2021 All hazard ratings were updated within the hazard narratives to reflect 2021 ratings The mitigation plan mission and goals were updated to reflect adoption of the 2021 county mission and goals Action item forms were updated to reflect status changes</p>
<p>City of Sisters</p>	<p>How the plan was developed was updated to include 2021 process Six new action items were developed (MH#1, FL#3, FL#4, WF#1, WF#2, WF#3) A status updated was provided for all existing action items One action item was removed (FL#2) The implementation process was updated to reflect the new county 2021 schedule A tribal land acknowledgement statement was added to the Community Profile and Asset Identification section The existing plans list was updated Community asset lists and tables were updated The Hazard Analysis Matrix and the vulnerability and probability comparisons with the county's ratings were updated to reflect 2021 scores and ratings Each hazard description includes at least one update to reflect new understanding of risks and vulnerabilities in 2021 All hazard ratings were updated within the hazard narratives to reflect 2021 ratings The mitigation plan mission and goals were updated to reflect adoption of the 2021 county mission and goals Action item forms were updated to reflect status changes and six new action item forms were added (MH#1, FL#3, FL#4, WF#1, WF#2, WF#3)</p>
<p>Volume IV: Mitigation Resources</p>	
<p>Appendix A: Action Item Forms</p>	<p>All existing action items were updated to reflect status changes in 2021 Priority action items were identified, marked, and provided with a detailed summary of actions taken since 2015 Four new action item forms were included (MH#8, MH#9, EQ#3, and WF#4) Existing action item MH#4 was updated for clarity</p>
<p>Appendix B: Planning and Public Process</p>	<p>The full appendix was updated to reflect the planning and public process for 2021</p>

Appendix C: Community Profile	All data, tables, and charts were updated with the best available information as of April 2021
Appendix D: Economic Analysis of Natural Hazard Mitigation Projects	The newest template was added from OPDR (2020)
Appendix E: Grant Programs and Resources	The newest template was added from OPDR (2020) and additional resources were identified and included by the local committee
Appendix F: Deschutes County Natural Hazards Community Survey	The 2015 community survey results were replaced with the results from the 2021 survey

2021 NHMP PUBLIC PARTICIPATION PROCESS

2021 NHMP Update

Deschutes County is dedicated to directly involving the public in the review and update of the natural hazard mitigation plan. Although members of the steering committee represent the public to some extent, the residents of Deschutes County, Bend, La Pine, Redmond, and Sisters are also given the opportunity to provide feedback about the Plan. The Plan will undergo a full review every five years.

Deschutes County made the Plan available via the Central Oregon Intergovernmental Council's website for public comment from June 7th, 2021 through the FEMA review period. Additionally, The County hosted a public input session (virtually) on June 7th, 2021. The cities of Bend, La Pine, Redmond, and Sisters had at least one representative present at the public input meeting. Materials and comments from the public input session on June 7th, 2021 are included as Attachment B in this Appendix.

Public Involvement Summary

COIC and Deschutes County issued a community preparedness survey in both English and Spanish in March 2021 to gauge household knowledge of mitigation tools and techniques to assist in reducing the risk and loss from natural hazards, as well as assessing household disaster preparedness. COIC and Deschutes County received a total of 30 responses to the survey in English, and one response to the survey in Spanish. A detailed report of responses is provided in Appendix F of this NHMP.

During the public review period of June 7, 2021 – September 1, 2021 there were **zero** comments received via the COIC project page for the Deschutes County NHMP update. Members of the steering committee provided edits and updates to the NHMP during this period as reflected in the final document.

There were 2 comments received at the virtual public input session on June 7th, 2021. Both came from employees of Mid State Electric and were related to Continuity of Operations Plans. Deschutes County EMS agreed follow up with them for further discussion. For a more detailed review of the comments, see Attachment B of this Appendix.

COIC sent quarterly updates to emergency management staff in the neighboring communities of Lane County, Klamath County, Lake County, Crook County, and the Confederated Tribes of Warm Springs. Additionally, these neighboring communities were invited to participate in steering committee meetings, as well as the public input meeting on June 7th, 2021 and were sent a copy of the draft Plan for comments through the review period of June 7, 2021 – September 1, 2021. **Zero** comments were received from neighboring communities throughout the update period.

Attachment A: Press Releases

COIC

Central Oregon Intergovernmental Council

FOR IMMEDIATE RELEASE:

Name: Shelby Knight
Title: Resilience Planner
Phone number: 541-548-9535
Email: sknight@coic.org



Jefferson and Deschutes Counties Are Asking for Public Input on Natural Hazard Preparedness and Risk to Support Updating Their Natural Hazard Mitigation Plans

March 9th, 2021, Bend, ORE — Deschutes County and Jefferson County are partnering with the Federal Emergency Management Agency (FEMA) and Central Oregon Intergovernmental Council (COIC) to collect public feedback to support updating their Natural Hazards Mitigation Plans (NHMPs). Both counties are offering individuals an opportunity to weigh in by filling out a public survey. The goal of the survey is to collect information from the community to better understand individuals' preparedness, risk, and vulnerability to natural hazards. This information will be used to support both counties in updating their NHMPs and will help improve coordination of hazard mitigation and risk reduction efforts within the counties.

Deschutes County Natural Hazards Survey

The survey is available in both English and Spanish. All individual survey responses are strictly confidential and are for research purposes only. The survey is open now through March 19th.

English: <https://www.surveymonkey.com/r/deschutesNHMP>



*To request this information in an alternate format, please call **541-728-3872** or send an email to emergency.management@deschutes.org*

Jefferson County Natural Hazards Survey

Surveys are available in English and Spanish. All individual survey responses are strictly confidential and are for research purposes only. The survey is open to the public now through March 15th.

English: <https://www.surveymonkey.com/r/JeffersonNHMP>



To request this survey in an alternate format, please call 541-475-6520 or send an email to ayoung@jcsso.law

Los condados Jefferson y Deschutes están pidiendo las sugerencias del público para complementar la actualización de los planes de mitigación para desastres naturales de estos

Marzo 9 del 2021, Bend, OR. – El condado Deschutes y el condado Jefferson en colaboración con el Federal Emergency Management Agency, FEMA (La Agencia federal administradora de emergencias) y el Central Oregon Intergovernmental Council, COIC (el Concilio intergubernamental del centro de Oregón) están recopilando sugerencias para complementar la actualización de sus Natural Hazards Mitigation Plans, NHMPs (Los Planes de mitigación para los desastres naturales). Ambos condados están ofreciendo a los individuos una oportunidad de opinar mediante una encuesta pública. La meta de la encuesta es recoger información de la comunidad para entender mejor la preparación individual, el riesgo y la vulnerabilidad a los desastres naturales. Esta información será usada para apoyar a ambos condados en la actualización de sus NHMPs y ayudará a mejorar la coordinación de la mitigación en desastres y los esfuerzos de reducir los riesgos en estos condados.

El Condado Deschutes

La encuesta para el Plan de mitigación para los desastres naturales está disponible en español. Todas las respuestas a las encuestas individuales son estrictamente confidenciales y son solo con el propósito de investigación. Por favor, complete la encuesta a continuación antes del 19 de marzo.

Español: <https://www.surveymonkey.com/r/deschutesNHMP-Espanol>



Para solicitar esta información en un formato alternativo, llame **541-728-3872** o envíe un correo electrónico a emergency.management@deschutes.org

El Condado Jefferson

La encuesta para el Plan de mitigación para los desastres naturales está disponible en español. Todas las respuestas a las encuestas individuales son estrictamente confidenciales y son solo con el propósito de investigación. Por favor, complete la encuesta a continuación antes del 15 de marzo.

Español: <https://www.surveymonkey.com/r/JeffersonNHMP-Espanol>



Para solicitar esta información en un formato alternativo, llame **541-475-6520** o envíe un correo electrónico a ayoung@jcsso.law

Central Oregon Intergovernmental Council (COIC) was designated a Council of Governments in 1972 under ORS 190 and serves the local governments of Central Oregon. COIC provides regional services for employment and training, alternative high school education, business loans, planning and governance, community and economic development, and public transportation services operated by Cascades East Transit.

Attachment B:

June 7th Public Input Meeting Materials and Notes



**Deschutes NHMP
Public Input Meeting**

June 07, 2021 – 6:00 - 7:00pm



Zoom Webinar Link:

<https://zoom.us/j/92681466482?pwd=Z2Zlc29LV1Erc1RaWktoR0l6dlJkQT09>

Meeting ID: 926 8146 6482 | **Passcode:** 909129 | **Call-in #:** +1 669 900 6833

TIME	TOPIC
6:00 – 6:15p (15 mins)	<p>Welcome and Process Overview</p> <ul style="list-style-type: none"> • Welcome/Agenda Overview/Zoom Overview <i>Shelby Knight, COIC Resilience Planner</i> • Process Overview <i>Nathan Garibay, Deschutes County Sheriff’s Office Emergency Manager</i> <i>Ashley Volz, Deschutes County Sheriff’s Office Emergency Services Coordinator</i> <ul style="list-style-type: none"> ○ What is the NHMP? ○ Why is it important? ○ What was our process for updating the document? ○ How can the public review and comment?
6:15-6:40p (25 mins)	<p>Review of Draft Plan</p> <ul style="list-style-type: none"> • Elements of the NHMP <i>Shelby Knight, COIC Resilience Planner</i> • Key Changes & Updates to the Plan <i>Shelby Knight, COIC Resilience Planner</i> <i>Nathan Garibay, Deschutes County Sheriff’s Office Emergency Manager</i> <i>Ashley Volz, Deschutes County Sheriff’s Office Emergency Services Coordinator</i>
6:40 – 6:55p (20 mins)	<p>Discussion and Q&A</p> <ul style="list-style-type: none"> • Facilitated Public Comments and Q&A <i>Shelby Knight, COIC Resilience Planner</i>

6:55 – 7p (5 mins)	Closing Comments <i>Shelby Knight, COIC Resilience Planner</i> <i>Nathan Garibay, Deschutes County Sheriff's Office Emergency Manager</i> <i>Ashley Volz, Deschutes County Sheriff's Office Emergency Services Coordinator</i>
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Deschutes County 2021 NHMP Process



Public Input Meeting - Notes

June 7, 2021 | Zoom | 6:00 - 7:00pm

This meeting was hosted by Deschutes County Office of Emergency Management and facilitated by Central Oregon Intergovernmental Council. Contact information for the panelists can be found in the materials for this meeting as well as at the end of these meeting notes. Materials for this meeting, including the agenda, meeting recording, and draft NHMP can be found at <https://www.coic.org/emergency-preparedness/natural-hazard-mitigation-plans/deschutes-county-nhmp/>.

Facilitator: Shelby Knight, Resilience Planner at COIC

Panelists: Nathan Garibay and Ashley Volz, Deschutes County Sheriff's Office of Emergency Management; Will Groves, Deschutes County Planning; Damian Szyrnyck, City of Bend Planning; Boone Zimmerlee, Deschutes County Fire Adapted Communities Coordinator.

Staff: Sienna Fitzpatrick, COIC; Hayley Riach, Deschutes County Sheriff's Office

1. Welcome and Process Overview

The meeting started with introductions and a review of the agenda and Zoom tools. Nathan and Ashley gave an overview of the NHMP process and why it is important for the county and the communities in Deschutes. In summary, the NHMP update is essential to be eligible for federal funding through FEMA for pre-disaster mitigation work as well as post-disaster recovery funding. The NHMP identifies hazards, vulnerabilities, and risks facing the region and prioritizes actions to reduce them. This plan looks at the whole county as well as each of the four incorporated communities (Bend, La Pine, Redmond, Sisters).

The NHMP Steering Committee has been meeting since January; what we have to share today is still a draft and we are looking for public input to improve that draft before it is submitted to OEM and FEMA for review. Public input is key to a successful NHMP process, as this is a community document. The draft is available for public comment until September 1, 2021 and can be found at the link at the top of these notes. Please email Sienna Fitzpatrick at sfitzpatrick@coic.org with any comments you have. We encourage public feedback.

2. Review of Draft Plan

Shelby gave an overview of each of the components of the plan. The plan elements can be found in the slides available on the project website.

3. Key Changes/Updates in the Plan

Shelby summarized the key elements of a successful NHMP review process (see slides). Ashley reviewed major updates made to the Plan in 2021 thus far and reviewed the hazard ranking process (available for viewing in the slides). Significant changes to hazard ranking involved Drought (from #6 to #4), and Earthquake (Cascadia), from #3 down to #6. A robust wildfire smoke section was included in the wildfire annex. Future climate variability sections were also added to relevant hazards in order to capture potential climate change impacts. Wind in the context of fire was emphasized in the update – these annexes overlap to show the connection between these two hazards. Information on hazard trees was also added to the windstorm annex. Windstorm and drought both had many additional hazard incidents in the last five years that were added to the history sections.

Nathan talked about the mitigation strategy action items; these mitigation action items and the hazard rankings are the most significant components of this plan. There are County wide items and jurisdictional items. He reviewed new action items and discussed their importance in mitigating new and relevant risks (MH#8, MH#9, EQ#3, and WF#4).

4. Discussion

Shelby opened up the meeting for public questions and comment.

Renita Cuevas (Mid State Electric, La Pine): Mid State is working on their business continuity plan and in that process, questions have come up around communications during a big event (wildfire, winter storm). She asked for recommendations for who to talk to when something happens and Mid State is unable to get a message out. Nathan said that it's important to have redundancy whether you're a utility or a citizen; hopefully during a disaster there will be some connection back to a public safety answering point (PSAP). This can be a number of ways; for internal communication structures, you should determine whether you have a network or VOIP system or a copper telephone (some legacy fax machines still have copper); he recommends having both. You can also try cellular or texting which won't always work. For critical infrastructure, he recommends having a satellite phone or similar to allow you to at least get emergency information out. A number of organizations are also tapping into amateur radio and auxiliary communications as a fallback. If all those things fail and you can get in touch with the City of La Pine, Deschutes Emergency Management will definitely be engaging with them during a disaster so contacting City Hall could be the fallback so they can pass it on to the County. They want to know how to use the emergency broadcast system if there was an issue – sounds like they're doing what they need to do at the moment. Reach out to Nathan if you have additional questions.

JD Powers (Mid State Electric, La Pine): JD is the Information Systems Manager for Mid State La Pine. He asked if there is a conduit through the County EMOC to get information out on the emergency broadcast system if they need to power down their systems. Nathan said they do have the ability to use mass notification tools depending on the circumstances and emergent nature of the event there are circumstances – he would need to work out details for that offline to make sure we know the situation and understand when that would need to be employed. Nathan added that the emergency broadcast system shouldn't be the first choice for an incident like that but they should talk about it to discuss the circumstances for that use. He also generally would like to have a discussion with folks in La Pine regarding planned public safety power outages as this is a new subject to tackle.

Meeting concluded at 6:45pm.

Contact information:

Shelby Knight, Resilience Planner, Central Oregon Intergovernmental Council
sknight@coic.org

Ashley Volz, Emergency Services Coordinator, Deschutes County Sheriff's Office
ashley.volz@deschutes.org

Nathan Garibay, Emergency Services Manager, Deschutes County Sheriff's Office
nathan.garibay@deschutes.org

Project Website: <https://www.coic.org/emergency-preparedness/natural-hazard-mitigation-plans/deschutes-county-nhmp/>

Comments on the Draft Deschutes County 2021 NHMP will be accepted until September 1, 2021. Please submit all comments to Sienna Fitzpatrick at sfitzpatrick@coic.org.

Steering Committee Process

Steering committee members possessed familiarity with the Deschutes County community and how it's affected by natural hazard events. The steering committee guided the update process through several steps including goal confirmation and prioritization, action item review and development and information sharing to update the plan and to make the plan as comprehensive as possible. The steering committee met on the following dates:

- **Meeting #1, Kickoff:** December 14th, 2020
- **Meeting #2, Hazard Annexes and Risk Assessment:** January 13th, 2021
- **Meeting #3, Risk Assessment Continued and Mitigation Strategy:** February 10th, 2021
- **Meeting #4, Mitigation Strategy Continued and Plan Implementation and Maintenance:** March 10th, 2021

The county steering committee formed under the guidance of Nathan Garibay, Deschutes County Emergency Services Manager. The steering committee invested considerable time into the mitigation plan, inside and outside of meetings throughout the update process. For a full list of steering committee member see the Acknowledgements section of this NHMP.

In addition, several project management meetings between project managers and support staff were held to coordinate and follow-up on steering committee outcomes, action items, and needs for additional discussion/information.

- **Meeting #1:** January 1st, 2021
- **Meeting #2:** February 23rd, 2021
- **Meeting #3:** May 12th, 2021

Finally, four separate formal meetings (one for each city) were held for updating the jurisdiction addenda.

- **Meeting #1, La Pine Addendum:** April 8th, 2021
- **Meeting #2, Sisters Addendum:** April 9th, 2021
- **Meeting #3, Redmond Addendum:** April 16th, 2021
- **Meeting #4, Bend Addendum:** April 28th, 2021

The local steering committees formed under the guidance of each of the conveners. The steering committees invested considerable time into the mitigation plan, inside and outside of meetings throughout the update process. For a full list of steering committee members for each jurisdiction, see the Acknowledgements section of this NHMP.

The following pages provide copies of meeting agendas and attendance reports from county and city steering committee meetings. All steering committee meetings were held virtually via Zoom given local, regional, and state guidance on COVID-19. Therefore, role was called and attendance recorded at each meeting by the facilitator and formally captured in meeting minutes. Additionally, Zoom attendance reports were automatically generated in place of sign-in sheets and are included below.

Attachment C:

Steering Committee Attendance and Materials

Meeting Agenda
Deschutes County NHMP Kickoff Meeting
 December 14, 2020
 9a-10a

Zoom Link: <https://zoom.us/j/93055544374?pwd=dVEzNG1xU0QzbXhadlhNaWNVR2hVUT09> |
Meeting ID: 930 5554 4374 | Password: 647131 | Phone: 1 253 215 8782

TIME	AGENDA ITEM
9a – 9:10a <i>10 minutes</i>	Welcome and Introductions – <i>Shelby Knight, COIC</i>
9:10a – 9:20a <i>10 minutes</i>	Purpose – <i>Nathan Garibay, Deschutes County Emergency Manager</i>
9:20a – 9:30a <i>10 minutes</i>	Roles – <i>Shelby Knight, COIC; Nathan Garibay, Deschutes County Emergency Manager</i> <ul style="list-style-type: none"> • COIC • Deschutes County • Steering Committee • Project Management Team
9:30a – 9:40a <i>10 minutes</i>	Timeline and Scope of Work – <i>Shelby Knight, COIC; Nathan Garibay, Deschutes County Emergency Manager</i> ATTACHMENT A
9:40a – 9:50a <i>10 minutes</i>	Match Tracking Process and Ask – <i>Sienna Fitzpatrick, COIC; Scott Aycock, COIC</i>
9:50a – 9:55a <i>5 minutes</i>	Follow Up and Next Steps – <i>Shelby Knight, COIC</i>

Zoom Attendance Report for December 14th, 2020

	Topic	Participants
	Deschutes County NHMP Kickoff Meeting	23
Name (Original Name)	User Email	
Shelby Knight (she/her) (Shelby Knight)	sknight@coic.org	
Geoffrey Wullschlager	gwullschlager@lapineoregon.gov	
Harry Ward		
Sienna Fitzpatrick (they/them)	sfitzpatrick@coic.org	
Ashley Volz	ashley.volz@deschutes.org	
Will Groves	willg@deschutes.org	
Damian Syrnyk		
Ben Duda		
Roger Johnson		
GORDONRFOSTER		
Scott Aycock (he/him) (Scott Aycock)	scotta@coic.org	
Damian Syrnyk		
Shad Campbell		
Scott Woodford		
David Phillips	dphillips@blackbutteranchfire.com	
Ed Keith	ed.keith@deschutes.org	
Vernita Ediger	vediger@coic.org	
Boone Zimmerlee	boone.zimmerlee@deschutes.org	
Larry Medina (He/Him/His)		
Nathan Garibay		
Cory Misyey		
Tanya Saltzman	tanya.saltzman@deschutes.org	
Deborah McMahon -		
David Pond		

Deschutes NHMP Steering Committee Meeting 1

January 13, 2021 – 3:00 - 5:00pm

Zoom Link:

<https://zoom.us/j/96962364043?pwd=czRtSTd1VGw1WmY0TDJya0swUlhoUT09>

Meeting ID: 969 6236 4043 | **Passcode:** 890788 | **Call-in #:** +1 669 900 6833

TIME	TOPIC	ATTACHMENTS
3:00 – 3:10p	Introductions & Agenda Review <i>Shelby Knight, COIC</i>	<u>Attachment A:</u> 2015 NHMP <u>Attachment B:</u> Agenda
3:10 – 3:20p	Review Timeline and Match Tracking <i>Shelby Knight, COIC ; Sienna Fitzpatrick, COIC</i> <ul style="list-style-type: none"> • Review timeline • Scheduling jurisdictional meetings • Public meeting process • Match tracking update – <i>Sienna</i> 	<u>Attachment C:</u> SOW and Timeline <u>Attachment D:</u> Rate Certification Template Letter <u>Attachment E:</u> Rate Certification Instructions
3:20 – 3:30p	Discuss general roles / responsibilities & format of meetings / updates <i>Shelby Knight, COIC</i>	
3:30 – 4:00p	Review and Update Section 2: Risk Assessment <ul style="list-style-type: none"> • Hazard Profile and ID <ul style="list-style-type: none"> ▪ New hazards? ▪ Hazard Annexes – how to incorporate ▪ Review • Vulnerability Assessment and Community Profile <ul style="list-style-type: none"> ▪ Review 	<u>Google Doc:</u> Section 2, Community Profile, and Hazard Annex Word Doc
4:00 – 4:45p	Risk Analysis – Group Scoring Exercise	<u>Attachment F:</u> Hazard Analysis Matrix Instructions <u>Attachment G:</u> Hazard Analysis Matrix (Blank)
4:45 – 5:00p	Wrap-Up and Action Items <ul style="list-style-type: none"> • “Homework” assignments for COIC and Committee Members • Next Meeting: February 10th 	

Zoom Attendance Report for January 13th, 2021

	Topic	Participants
	Deschutes County NHMP Steering Committee	26
Name (Original Name)	User Email	
Shelby Knight (she/her)	sknight@coic.org	
Sienna F. (they/them)		
Deborah McMahon		
Damian Syrnyk		
judyl		
Geoff Wullschlager		
Ashley Volz	ashley.volz@deschutes.org	
aaron wells		
Scott Woodford	swoodford@ci.sisters.or.us	
Ed Keith	ed.keith@deschutes.org	
Ben Duda		
Mandy (PGE) (E06477)		
Bill Boos (Billy B)		
Melinda Campbell		
Will Groves	willg@deschutes.org	
Tanya Saltzman	tanya.saltzman@deschutes.org	
Roger Johnson		
Jeremy Giffin (giffinjt)		
David Pond		
Ariel Cowan - OSU Extension (Cowan# Ariel)	cowana@oregonstate.edu	
Scott Aycock	scotta@coic.org	
Boone Zimmerlee	boone.zimmerlee@deschutes.org	
Nathan Garibay		
David Phillips	dphillips@blackbutteranchfire.com	
Jared Earnest		
Bill Boos		

Deschutes NHMP Steering Committee Meeting 2

February 10, 2021 – 3:00 - 5:00pm

Zoom Link:

<https://zoom.us/j/96962364043?pwd=czRtSTd1VGw1WmY0TDJya0swUlhoUT09>

Meeting ID: 969 6236 4043 | **Passcode:** 890788 | **Call-in #:** +1 669 900 6833

TIME	TOPIC	ATTACHMENTS
3:00 – 3:15p <i>(15 mins)</i>	Introductions & Agenda Review <ul style="list-style-type: none"> • Attendance • Review agenda 	<u>Attachment A:</u> Agenda
3:15-3:30 <i>(15 mins)</i>	Housekeeping Items <ul style="list-style-type: none"> • <u>Action</u> - approve notes • Scheduling jurisdictional meetings • Match tracking/tracking individual hours 	<u>Attachment B:</u> 1/13 Meeting Notes
3:30 – 4:00p <i>(30 mins)</i>	Section 2: Risk Assessment Changes Review <ul style="list-style-type: none"> • HVA discussion • “Extreme Heat” and “Wildfire Smoke” • Review and approve changes • Discuss information still needed/assign 	<u>Attachment C:</u> Changes Memo <u>Attachment D:</u> Extreme Heat Considerations
4:00 – 4:45p <i>(45 mins)</i>	Section 3: Mitigation Strategy Review <ul style="list-style-type: none"> • Mission and Goals • Update status of existing actions • Discuss new actions • Prioritize actions 	<u>Google Doc – Section 3:</u> Mitigation Strategy <u>Attachment E:</u> Section 3 – Mitigation Strategy (Excel) <u>Attachment F:</u> 2020 Oregon NHMP Mitigation Strategy <u>Attachment G:</u> Action Item Worksheet
4:45 – 5:00p <i>(15 mins)</i>	Wrap-Up and Action Items <ul style="list-style-type: none"> • “Homework” assignments for COIC and Committee Members • Next Meeting: March 10th <ul style="list-style-type: none"> ○ Section 4: Plan Implementation and Maintenance ○ Volume IV: Mitigation Resources of the 2016 NHMP 	

Zoom Attendance Report for February 10th, 2021

	Topic	Participants
	Deschutes County NHMP Steering Committee	23
Name (Original Name)	User Email	
Shelby Knight (she/her)	sknight@coic.org	
Sam Vanlaningham (OWRD) (Sam)	samvanlan@gmail.com	
Boone Zimmerlee	boone.zimmerlee@deschutes.org	
Damian Syrnyk		
Geoff Wullschlager		
Marc Austin - NWS Pendleton		
Ashley Volz	ashley.volz@deschutes.org	
David Pond		
Tanya Saltzman# Senior Planner		
Shad Campbell		
Scott Woodford		
Sienna F. (they/them)	sfitzpatrick@coic.org	
Deborah McMahon		
Jared Earnest		
Roger Johnson		
Ben Duda		
Melinda Campbell		
Peter Brewer	brewer.peter@deq.state.or.us	
Ariel Cowan - OSU Extension (Cowan# Ariel)	cowana@oregonstate.edu	
Will Groves	willg@deschutes.org	
Bill Boos		
Nathan Garibay		
Shad Campbell		

Deschutes NHMP Steering Committee

Meeting 3 Agenda

March 10, 2021 – 3:00 - 5:00pm

Zoom Link:

<https://zoom.us/j/96962364043?pwd=czRtSTd1VGw1WmY0TDJya0swUlhoUT09>

Meeting ID: 969 6236 4043 | **Passcode:** 890788 | **Call-in #:** +1 669 900 6833

TIME	TOPIC	ATTACHMENTS
3:00 – 3:15p (15 mins)	Introductions & Agenda Review <ul style="list-style-type: none"> • Attendance • Review agenda 	<u>Attachment A:</u> Agenda
3:15-3:30 (15 mins)	Housekeeping Items <ul style="list-style-type: none"> • <u>Action</u> - approve notes • April: jurisdictional meetings • Public survey 	<u>Attachment B:</u> 2/10 Meeting Notes
3:30 – 3:50p (20 mins)	Section 2: Risk Assessment <ul style="list-style-type: none"> • <u>Action</u> - HVA review and approve • Discuss info still needed/assign 	<u>Attachment C:</u> HVA Update <u>Attachment D:</u> PMT Notes
3:50 – 4:35p (45 mins)	Section 3: Mitigation Strategy <ul style="list-style-type: none"> • Review and update goals • Review Changes/Discuss info still needed • Brainstorm and develop new action items • Prioritize actions 	<u>Google Doc/Attachment H</u> – Section 3: Action Item Matrix <u>Attachment E:</u> Section 3 Changes Memo <u>Attachment F:</u> 2020 Oregon NHMP Mitigation Strategy <u>Attachment G:</u> Action Item Worksheet
4:35 – 4:50 (20 mins)	Section 4: Plan Implementation and Maintenance <ul style="list-style-type: none"> • Review/update/assign Appendix E: Grant Programs and Resources <ul style="list-style-type: none"> • Review/update/assign 	<u>Google Doc</u> – Section 4: Plan Implementation and Maintenance <u>Google Doc</u> – Appendix E: Grant Programs and Resources
4:50 – 5:00p (10 mins)	Wrap-Up and Action Items <ul style="list-style-type: none"> • “Homework” assignments for COIC and Committee Members • Next Meeting: <ul style="list-style-type: none"> ○ April Jurisdictional Meetings ○ SC May 12th 	

Zoom Attendance Report for March 10th, 2021

	Topic	Participants
	Deschutes County NHMP Steering Committee	26
Name (Original Name)	User Email	
Shelby Knight (she/her)	sknight@coic.org	
Sienna F. (they/them)		
Deborah McMahon		
Damian Syrnyk		
judyl		
Geoff Wullschlager		
Ashley Volz	ashley.volz@deschutes.org	
aaron wells		
Scott Woodford	swoodford@ci.sisters.or.us	
Ed Keith	ed.keith@deschutes.org	
Ben Duda		
Mandy (PGE) (E06477)		
Bill Boos (Billy B)		
Melinda Campbell		
Will Groves	willg@deschutes.org	
Tanya Saltzman	tanya.saltzman@deschutes.org	
Roger Johnson		
Jeremy Giffin (giffinjt)		
David Pond		
Ariel Cowan - OSU Extension (Cowan# Ariel)	cowana@oregonstate.edu	
Scott Aycock	scotta@coic.org	
Boone Zimmerlee	boone.zimmerlee@deschutes.org	
Nathan Garibay		
David Phillips	dphillips@blackbutteranchfire.com	
Jared Earnest		
Bill Boos		

La Pine NHMP Addendum Update

Meeting Agenda

April 8, 2021 – 11:00 - 2:00pm

Zoom Link:

<https://zoom.us/j/96429273206?pwd=bGVubTlrTEI2UHJSR2pNTm1ieXU0dz09>

Meeting ID: 964 2927 3206| **Passcode:** 278739| **Call-in #:** +1 253 215 8782

TIME	TOPIC	ATTACHMENTS
11:00 – 11:15a <i>(15 mins)</i>	Introductions & Agenda Review <ul style="list-style-type: none"> • Attendance • Review agenda 	<u>Attachment A:</u> Agenda
11:15-11:30a <i>(15 mins)</i>	Process Overview <ul style="list-style-type: none"> • Purpose and Need <i>(Nathan)</i> • Roles • Timeline and Scope of Work 	<u>Attachment B:</u> Timeline and SOW <u>Attachment C:</u> Draft County NHMP 2021
11:30-12:00p <i>(30 mins)</i>	Community Profile Asset Identification <ul style="list-style-type: none"> • Critical and essential facilities • Population • Land Use • Parks and Open Space • Economic Resources • Cultural and Historic Resources 	<u>Google Doc:</u> La Pine Addendum
12:00 – 12:45p <i>(45 mins)</i>	Risk Assessment <ul style="list-style-type: none"> • HAM: Review and Approve • Review/Update Hazard Profiles <ul style="list-style-type: none"> ○ Drought ○ Earthquake ○ Flood ○ Landslide ○ Volcano ○ Wildfire ○ Windstorm ○ Winter Storm 	<u>Google Doc:</u> Updated City & County Hazard Analysis Matrices <u>Google Doc:</u> La Pine Addendum
12:55 – 1:40p <i>(45 mins)</i>	Mitigation Strategy <ul style="list-style-type: none"> • Review and approve mission and goals • Status update for mitigation actions • Brainstorm and develop new action items 	<u>Google Doc:</u> La Pine Addendum <u>Google Doc:</u> La Pine Mitigation Action Plan
1:40 – 1:55 <i>(15 mins)</i>	Plan Implementation and Maintenance <ul style="list-style-type: none"> • Review and update 	<u>Google Doc:</u> La Pine Addendum
1:55 – 2:00p <i>(5 mins)</i>	Wrap-Up and Action Items <ul style="list-style-type: none"> • “Homework” assignments for COIC and Committee Members 	

Zoom Attendance Report for April 8th, 2021

	Topic	Participants
	La Pine NHMP Meeting	19
Name (Original Name)	User Email	
Sam VanLaningham		
Cory Jones		
Ciara Williams	cwilliams@coic.org	
Nathan Garibay	nathan.garibay@deschutes.org	
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Sienna F. (they/them)	sfitzpatrick@coic.org	
Geoff Wullschlager		
Marie Manes		
tom Weller		
Oliver Tatom	owtatom@stcharleshealthcare.org	
arepko		
Will Groves	willg@deschutes.org	
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mhibbs		
chiefsupkis		
Charla DeHate		
Boone Zimmerlee	boone.zimmerlee@deschutes.org	

Sisters NHMP Addendum Update

Meeting Agenda

April 9, 2021 – 2:00 - 5:00pm

Zoom Link: <https://zoom.us/j/91725479520?pwd=SGx1M1JkRzQ3WUJQb1I5MUhJVHhWQT09>
Meeting ID: 917 2547 9520 | **Passcode:** 703103 | **Call-in #:** +1 669 900 6833

TIME	TOPIC	ATTACHMENTS
2:00 – 2:15 <i>(15 mins)</i>	Introductions & Agenda Review <ul style="list-style-type: none"> • Attendance • Review agenda 	<u>Attachment A:</u> Agenda
2:15-2:30 <i>(15 mins)</i>	Process Overview <ul style="list-style-type: none"> • Purpose and Need <i>(Nathan)</i> • Roles • Timeline and Scope of Work 	<u>Attachment B:</u> Timeline and SOW <u>Attachment C:</u> Draft County NHMP 2021
2:30-3:00 <i>(30 mins)</i>	Community Profile Asset Identification <ul style="list-style-type: none"> • Critical and essential facilities • Population • Land Use • Parks and Open Space • Economic Resources • Cultural and Historic Resources 	<u>Google Doc:</u> Sisters Addendum
3:00 – 3:45 <i>(45 mins)</i>	Risk Assessment <ul style="list-style-type: none"> • HAM: Review and Approve • Review/Update Hazard Profiles <ul style="list-style-type: none"> ○ Drought ○ Earthquake ○ Flood ○ Landslide ○ Volcano ○ Wildfire ○ Windstorm ○ Winter Storm 	<u>Google Doc:</u> Updated City & County Hazard Analysis Matrices <u>Google Doc:</u> Sisters Addendum
3:55 – 4:40 <i>(45 mins)</i>	Mitigation Strategy <ul style="list-style-type: none"> • Review and approve mission and goals • Status update for mitigation actions • Brainstorm and develop new action items 	<u>Google Doc:</u> Sisters Addendum <u>Google Doc:</u> Sisters Mitigation Action Plan
4:40 – 4:55 <i>(15 mins)</i>	Plan Implementation and Maintenance <ul style="list-style-type: none"> • Review and update 	<u>Google Doc:</u> Sisters Addendum
4:55 – 5:00 <i>(5 mins)</i>	Wrap-Up and Action Items <ul style="list-style-type: none"> • “Homework” assignments for COIC and Committee Members 	

Zoom Attendance Report for April 9th, 2021

	Topic	Participants
	Sisters NHMP Meeting	17
Name (Original Name)	User Email	
Sam VanLaningham	sam.j.vanlaningham@oregon.gov	
James Osborne		
Shelby Knight (she/her)	sknight@coic.org	
Emme Shoup	eshoup@uoregon.edu	
Ashley Volz	ashley.volz@deschutes.org	
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Roger Johnson		
Ian Reid (Ian Reid# Deschutes NF)		
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Andrea blum		
Curt Scholl		
Paul Bertagna		
Brent	btenpas@cec.coop	

Redmond NHMP Addendum Update

Meeting Agenda

April 16, 2021 – 8:00 - 11:00am

Zoom Link:

<https://zoom.us/j/92112390702?pwd=ek56dGtESE5QRnM2OU92OUxUeGZ3Zz09>

Meeting ID: 921 1239 0702 | **Passcode:** 468052 | **Call-in #:** +1 253 215 8782

TIME	TOPIC	ATTACHMENTS
8:00 – 8:15a <i>(15 mins)</i>	Introductions & Agenda Review <ul style="list-style-type: none"> • Attendance • Review agenda 	<u>Attachment A:</u> Agenda
8:15-8:30a <i>(15 mins)</i>	Process Overview <ul style="list-style-type: none"> • Purpose and Need (<i>Ashley</i>) • Roles • Timeline and Scope of Work 	<u>Attachment B:</u> Timeline and SOW <u>Attachment C:</u> Draft County NHMP 2021
8:30-9:00a <i>(30 mins)</i>	Community Profile Asset Identification <ul style="list-style-type: none"> • Critical and essential facilities • Population • Land Use • Parks and Open Space • Economic Resources • Cultural and Historic Resources 	<u>Google Doc:</u> Redmond Addendum
9:00 – 9:45a <i>(45 mins)</i>	Risk Assessment <ul style="list-style-type: none"> • HAM: Review and Approve • Review/Update Hazard Profiles <ul style="list-style-type: none"> ○ Drought ○ Earthquake ○ Flood ○ Landslide ○ Volcano ○ Wildfire ○ Windstorm ○ Winter Storm 	<u>Google Doc:</u> City Hazard Analysis Matrix <u>Google Doc:</u> Redmond Addendum
9:45 – 10:30a <i>(45 mins)</i>	Mitigation Strategy <ul style="list-style-type: none"> • Review and approve mission and goals • Status update for mitigation actions • Brainstorm and develop new action items 	<u>Google Doc:</u> Redmond Addendum <u>Google Doc:</u> Redmond Mitigation Action Plan
10:30 – 10:45a <i>(15 mins)</i>	Plan Implementation and Maintenance <ul style="list-style-type: none"> • Review and update 	<u>Google Doc:</u> Redmond Addendum
10:45 – 11:00a <i>(15 mins)</i>	Wrap-Up and Action Items <ul style="list-style-type: none"> • “Homework” assignments for COIC and Committee Members 	

Zoom Attendance Report for April 16th, 2021

	Topic	Participants
	Redmond NHMP Meeting	10
Name (Original Name)	User Email	
Sam VanLaningham	sam.j.vanlaningham@oregon.gov	
jpuckett		
Deborah McMahon		
Sienna F. (they/them)	sfitzpatrick@coic.org	
Ashley Volz	ashley.volz@deschutes.org	
Ken Kehmna	ken.kehmna@redmondfireandrescue.org	
John Roberts		
Bill Duerden		
Sam VanLaningham	sam.j.vanlaningham@oregon.gov	

Bend NHMP Addendum Update

Meeting Agenda

April 28, 2021 – 12:00 - 3:00pm

Zoom Link:

<https://zoom.us/j/98938563296?pwd=cTJxbHVxNTNUOTJhaklrYUxOQk1FUT09>

Meeting ID: 989 3856 3296 | Passcode: 172620 | Call-in #: +1 669 900 6833

TIME	TOPIC	ATTACHMENTS
12:00 – 12:15p (15 mins)	Introductions & Agenda Review <ul style="list-style-type: none"> Attendance Review agenda 	<u>Attachment A</u> : Agenda
12:15-12:30p (15 mins)	Process Overview <ul style="list-style-type: none"> Purpose and Need (<i>Nathan/Ashley</i>) Roles Timeline and Scope of Work 	<u>Attachment B</u> : Timeline and SOW <u>Attachment C</u> : Draft County NHMP 2021
12:30-12:50p (20 mins)	Community Profile Asset Identification <ul style="list-style-type: none"> Critical and Essential Facilities Pop/Land Use Economic/Cultural/Historic 	<u>Google Doc 1</u> : Bend Addendum
12:50 – 1:35p (45 mins)	Risk Assessment <ul style="list-style-type: none"> Hazard Analysis Matrix: Update and Approve Review/Update Hazard Profiles <ul style="list-style-type: none"> Drought Earthquake Flood Landslide Volcano Wildfire Windstorm Winter Storm 	<u>Google Doc 2</u> : Bend and County Hazard Scores <u>Google Doc 1</u> : Bend Addendum
1:45 – 2:30p (45 mins)	Mitigation Strategy <ul style="list-style-type: none"> Review and approve mission and goals Status update for mitigation actions Approve new action items 	<u>Google Doc 1</u> : Bend Addendum <u>Google Doc 2</u> : Bend and County Mitigation Action Plan <u>Attachment D</u> : Action Item Worksheet
2:30 – 2:45 (15 mins)	Plan Implementation and Maintenance <ul style="list-style-type: none"> Review and update 	<u>Google Doc 1</u> : Bend Addendum
2:45 – 3:00p (15 mins)	Wrap-Up and Action Items <ul style="list-style-type: none"> “Homework” assignments for COIC and Committee Members 	

Zoom Attendance Report for April 16th, 2021

	Topic	Participants
	Bend NHMP Meeting	10
Name (Original Name)	User Email	
Boone Zimmerlee (Boone)		
Shelby Knight (she/her)	sknight@coic.org	
Damian Syrnyk		
Dan Fishkin (Dan)		
Ciara Williams	cwilliams@coic.org	
Hayley Riach (she/her)		
Nathan Garibay	nathan.garibay@deschutes.org	
Boone Zimmerlee	boone.zimmerlee@deschutes.org	
Bill Boos		
Dan		

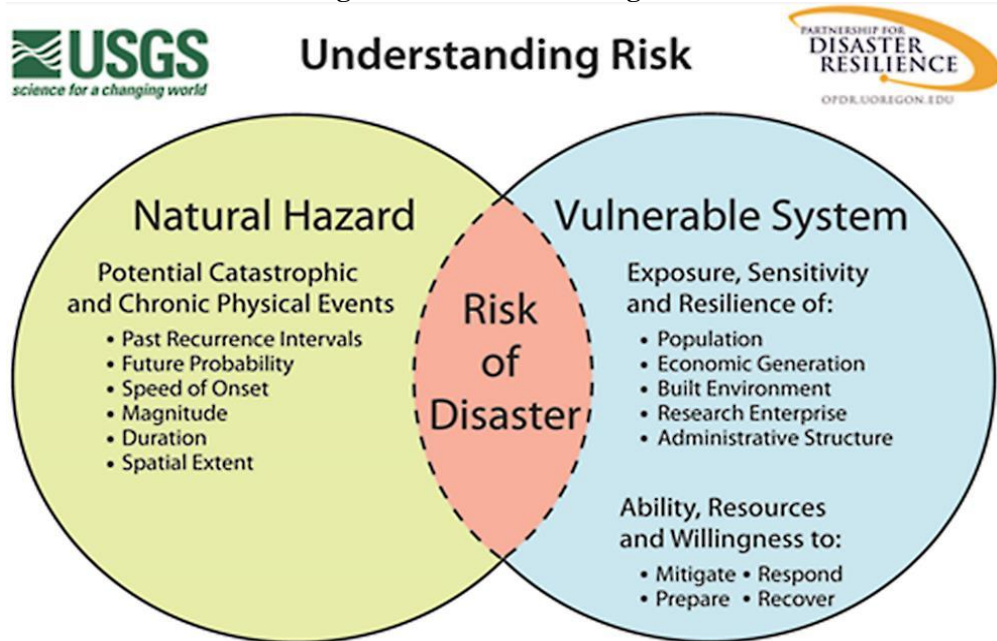
APPENDIX C: COMMUNITY PROFILE

Community resilience can be defined as the community’s ability to manage risk and adapt to natural hazard impacts. In order to help define and understand the County’s sensitivity and resilience to natural hazards, the following capacities must be examined:

- **Natural Environment**
- **Social/ Demographic**
- **Economic**
- **Built Environment**
- **Community Connectivity**
- **Political**

The Community Profile describes the sensitivity and resilience to natural hazards of Deschutes County, and its incorporated cities, as they relate to each capacity. It provides a snapshot in time when the plan was developed and will assist in preparation for a more resilient county. The information in this section, along with the hazard assessments located in the Hazard Annex, should be used as the local level rationale for the risk reduction actions identified in Section 3 – Mitigation Strategy. The identification of actions that reduce the county’s sensitivity and increase its resiliency assist in reducing overall risk of disaster, the area of overlap in the figure below.

Figure C-1 Understanding Risk



Source: Oregon Partnership for Disaster Resilience

Natural Environment Capacity

Natural environment capacity is recognized as the geography, climate, and land cover of the area such as, urban, water and forested lands that maintain clean water, air and a stable climate.¹ Natural resources such as wetlands and forested hill slopes play significant roles in protecting communities and the environment from weather-related hazards, such as flooding and landslides. However, natural systems are often impacted or depleted by human activities adversely affecting community resilience.

Geography

Deschutes County is located in Central Oregon along the eastern side of the Cascades, and covers 3,055 square miles. The region is diverse and comprises high desert, mountain ranges, plateaus, river valleys, canyons, lava plains and partly forested mountains, with elevations ranging from 2,700 feet to 10,358 at the peak of South Sister. ²

The county is located within several eco-regions: the Eastern Cascades Slopes and Foothills, the Cascades, Northern Basin and Range, and the Blue Mountains. The Deschutes River Valley lies in the northeast section of the county and covers the area of Bend, Redmond, and Sisters. La Pine is located within the Eastern Cascades Slopes and Foothills area in the southwest portion of the county. The Northern Basin and Range ecoregion in southeast Deschutes County consists of pluvial lake basins. In the Eastern Cascades Slopes and Foothills, located across the County, the eco-region includes ponderosa pine/ bitterbrush woodland, cold wet pumice plateau basin and pumice plateau forests. Lastly, the Cascades ecoregion in Deschutes County is located along the western border and in some southern areas in the County. The Cascades ecoregion geography includes Cascade Crest Montane Forests and Cascades Subalpine/alpine. ³

Deschutes River Basin

The Deschutes River Basin covers the majority of the County. Groundwater inflow on stream flows and volcanic activity influence the characteristics of upper Deschutes River Basin. Recent geology activity such as lava flows, pumice, and ash along with the glacial movement has reworked much of the area. It has allowed subsurface flows to travel in large quantities and at relatively rapid rates. This has resulted in a steady hydrologic flow with minimal fluctuations compared to rivers dominated by surface runoff.⁴

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. Estimated future climate conditions and possible impacts are also provided (for a more detailed analysis refer to the State Risk Assessment).

¹ Mayunga, J. 2007. Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. Summer Academy for Social Vulnerability and Resilience Building.

² Monroe, William. Deschutes County Comprehensive Plan. Resource Element 1979.

³ Loy, W. G., ed. 2001. Atlas of Oregon, 2nd Edition. Eugene, OR: University of Oregon Press

⁴ Deschutes County/City of Bend River Study. April 1986

Temperature

There is a large temperature range in Deschutes County. Deschutes' climate is typical of a high desert with cool nights and sunny days. Mean summer temperatures range from highs around 90 degrees Fahrenheit to lows around 40 degrees Fahrenheit. Mean winter temperatures range from highs around 50 degrees Fahrenheit to lows around 10 degrees Fahrenheit. The table below shows the mean annual rainfall ranges and temperatures for January and July for the various eco-regions of the county.

Table C-1 Average Rainfall and Temperatures

Ecoregion	Mean Annual Rainfall Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades			
Cascade Crest Montane Forest	55 to 100	21/35	43/72
Cascades Subalpine/ Alpine	75 to 140	36/48	52/68
Eastern Cascades Slopes and Foothills			
Ponderosa Pine/ Bitterbrush Woodland	16 to 35	20/40	40/82
Pumice Plateau	16 to 30	14/37	38/80
Pumice Plateau Basins	20 to 25	12/38	38/80
Blue Mountains			
Deschutes River Valley	8 to 12	22/41	46/84
Northern Basin and Range			
Pluvial Lake Basins	8 to 12	17/38	42/82
High Lava Plains	8 to 14	17/35	54/88

Source: US EPA. Ecoregions of Oregon: http://www.epa.gov/wed/pages/ecoregions/or_eco.htm

Temperatures in the Pacific Northwest region increased in the 20th Century by about 1.5 degrees Fahrenheit. Climate projection models indicate that temperatures could increasingly rise by an average of 0.2 degrees to 1.0 degrees Fahrenheit per decade. Average temperature change is projected to be 3.2 degrees Fahrenheit by 2040 and 5.3 degrees Fahrenheit by 2080. Temperature increases will occur throughout all seasons, with the greatest differences occurring in the summer months.⁵

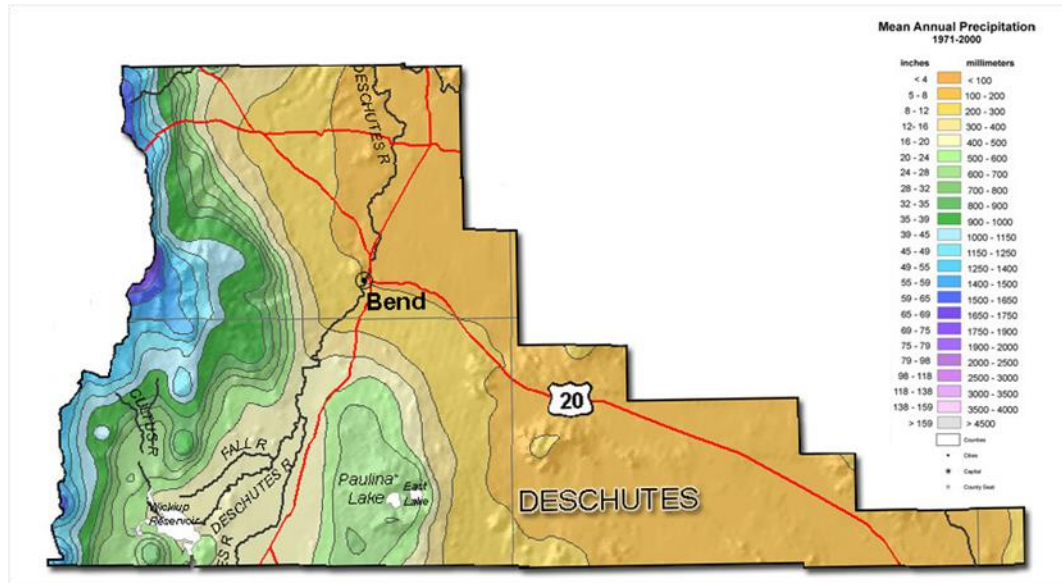
Precipitation

The region receives relatively low levels of precipitation, approximately 8-35 inches per year (increased levels of precipitation occur in the mountains to the west of the populated areas of the county). This is in contrast to the 37 to 50 inches normally seen in other parts of the Pacific Northwest. There is large annual temperature variation with mean temperatures anywhere from the high fifties to seventies, and the maximum high temperature up to 102 degrees Fahrenheit from June to September, to average highs of low teens in the winter months. In most winters, there are frequent and severe winter storms characterized by temperature, wind

⁵ Climate Impacts Group, "Climate Change," <http://cses.washington.edu/cig/pnwc/cc.shtml#anchor6>.

velocity, ground saturation, and snowpack. Winter storms can slow or halt traffic, damage power lines, and kill livestock. Summer precipitation is relatively low, increasing the risk of wildfire and requiring irrigation for crops.

Figure C-2 Deschutes County Average Annual Precipitation



Source: The Oregon Climate Service, NOAA Climate Stations. "1971-2000 Climate of Deschutes County".

Total precipitation in the Pacific Northwest region may remain similar to historic levels but climate projections indicate the likelihood of increased winter precipitation and decreased summer precipitation.⁶

Increasing temperatures affects hydrology in the region. Spring snowpack has substantially decreased throughout the Western part of the United States, particularly in areas with milder winter temperatures, such as the Cascade Mountains. In other areas of the West, such as east of the Cascades Mountains, snowfall is affected less by the increasing temperature because the temperatures are already cold and more by precipitation patterns.⁷

Hazard Severity

Dynamic weather and diverse geography across Deschutes County are indicators of hazard vulnerability when combined with the changing climate and severe weather related events. Both wet and dry cycles are likely to last longer and be more extreme, leading to periods of deeper drought and more frequent flash flooding. Less precipitation in the summers and subsequently lower soil moisture with hotter temperatures will likely increase the amount of vegetation, such as rangeland and grasslands, consumed by wildfire.

⁶ Ibid.

⁷ Mote, Philip W., et. al., "Variability and trends in Mountain Snowpack in Western North America," <http://cses.washington.edu/db/pdf/moteetalvarandtrends436.pdf>

Synthesis

The physical geography, weather, climate and land cover of an area represent various interrelated systems that affect overall risk and exposure to natural hazards. The projected climate change models representing Central Oregon indicate the potential for increased effects of hazards, particularly drought and wildfire due to the changing climate of the region. Central Oregon is projected to have warmer and drier summers with less precipitation. In addition, winter temperatures will be warmer, which means a decrease in mountain snowpack. These factors combined with periods of population growth and development intensification can lead to increasing risk of hazards, threatening loss of life, property and long-term economic disruption if land management is inadequate.

Social/Demographic Capacity

Social/demographic capacity is a significant indicator of community hazard resilience. The characteristics and qualities of the community population such as language, race and ethnicity, age, income, educational attainment, and health are significant factors that can influence the community's ability to cope, adapt to and recover from natural disasters. Population vulnerabilities can be reduced or eliminated with proper outreach and community mitigation planning. Deschutes County has a variety of residential community types: incorporated cities, unincorporated urban communities, rural communities, rural service centers, resort communities, and destination resorts.⁸ Listed below are the residential communities by type:

Incorporated Cities

Incorporated cities can levy taxes on residents and are required to provide services such as electricity, sewer, and water. The following list shows incorporated cities and their date of incorporation:

- Bend (1/19/1905)
- La Pine (12/11/2006)
- Redmond (7/16/1910)
- Sisters (4/9/1946)

Urban Unincorporated Communities

Urban unincorporated communities have a minimum of 150 permanent residential dwellings, have three or more land use types, and are served by community sewer and water systems. Sunriver is the only unincorporated urban community in Deschutes County. The community is approximately 3,375 acres, was master planned in 1965, and has an estimated 1,733 permanent residents (during peak tourist seasons the population expands by approximately 12,000 residents). Additional information on Sunriver can be found in the Deschutes Comprehensive Plan Section 4.5.

Rural Communities

Rural communities are primarily composed of residential land, but also have some employment land (commercial, industrial), and public land that serve the surrounding area. There are two rural communities in Deschutes County:

- Terrebonne – Located about six miles north of Redmond, this community was platted in 1909 and is the gateway to Smith Rock State Park, a premier rock climbing venue. The community has a population of about 1,658⁹ in 2019. According to a 2009 vacant lands inventory, the community had 186 undeveloped lots.
- Tumalo–Located about three miles northwest of Bend the community was platted in 1904 and is a small farming community with most farms on fewer than five acres. The community has a population of about 535. According to a 2009 vacant lands inventory

⁸ Deschutes County, Oregon Adopted Budget Fiscal Year 2015.

⁹ U.S. Census, American Community Survey 2019 5-Year Profile, Table DP05.

the community had 103 undeveloped lots. The community of Tumalo is bisected by the Deschutes River and includes land that is within the special flood hazard area.

Resort Communities

Resort communities established for recreation or resort purposes predate the establishment of the destination resort designation. These communities primarily contain temporary residential units, and some permanent residences, and commercial and industrial services to support the community. Deschutes County has two resort communities:

- Black Butte Ranch-Founded in 1970 this community has 1,830 acres, with 1,252 lots for seasonal and permanent residents; in addition there are 82 acres of industrial uses that support the community.
- Inn of the Seventh Mountain/ Widgi Creek-Located about five miles southwest of Bend, this community was developed in the late 1960's with an expansion that occurred in 1983. The 260 acre community has 333 condominium units, 107 single family homes, a golf course, and commercial development primarily geared towards residents/ tourists. The community is completely surrounded by the Deschutes National Forest.

Destination Resorts

Destination resort communities are self-contained developments that include developed recreational amenities in a natural setting. These communities were permitted under revised statewide planning laws in 1982. Under state law (ORS 197.455(2)), destination resorts are only allowed in areas designated on a county destination resort map. In 1992, the County supplemented the state's criteria by excluding large agricultural and forest parcels and resource lands within one mile of an Urban Growth Boundary (UGB). During periodic review, the mapping was done in a phased sequence, based on pending farm and forest studies. Additionally, as a result of a court case, lands within three miles of the county border were also excluded since most of the lands in Jefferson and Crook counties had not yet been evaluated.

Deschutes County has four destination resorts: Caldera Springs, Eagle Crest, Pronghorn, and Tetherow.

Notably, new destination resorts will no longer be eligible in Deschutes County when the City of Bend UGB reaches 100,000. Deschutes County Comprehensive Plan Policy 3.9.3(a)(1), which is consistent with ORS 197.455(1)(a) states:

To assure that resort development does not conflict with the objectives of other Statewide Planning Goals, destination resorts shall pursuant to Goal 8 not be sited in Deschutes County in the following areas:

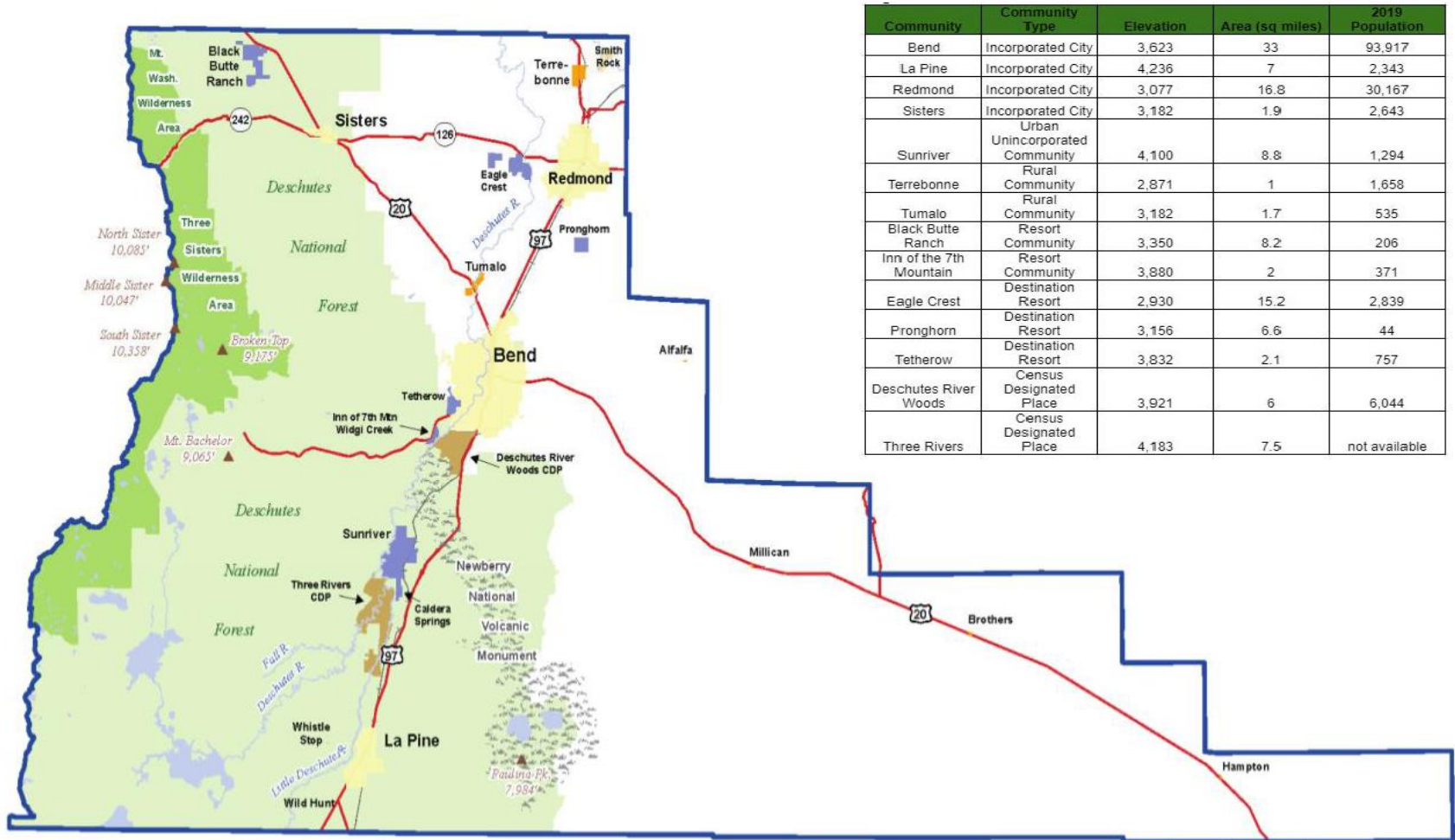
- Within 24 air miles of an Urban Growth Boundary with an existing population of 100,000 or more unless residential uses are limited to those necessary for the staff and management of the resort.

Portland State University's Population Research Center is an interdisciplinary public service, research, and training unit for population-related data and research for the State of Oregon. The 2020 forecast for the City of Bend, certified on December 15, was 92,840.

Rural Service Centers

The comprehensive plan designates six areas as rural service centers (unincorporated communities that were developed prior to 1979 and recognized as exception areas from Goals 3 and 4): Alfalfa, Brothers, Hampton, Millican, Whistlestop, and Wildhunt.

Figure C-3 Deschutes County Map



Source: Deschutes County Fiscal Year 2021 Adopted Budget (map); U.S. Census American Community Survey 5-Year Estimates, 2019 (population data).

Population

The majority of people across Deschutes County reside in Bend or within the unincorporated areas of the county. Between 2010 and 2019, Deschutes County experienced a 22.4% increase in population.¹⁰ The Portland State University Population Research Center projects that by 2035 Deschutes County’s population will increase to 266,840 people, a 34% increase.¹¹

Bend is by far the most populated city in the county, followed by Redmond; Sisters and La Pine are significantly smaller communities. The table below shows that population growth between 2000 and 2010 occurred in all areas of the county. However, growth in the unincorporated county was slower than in the cities. . The Coordinated Population Forecast projects that La Pine and Sisters will be the fastest growing communities between 2018 and 2043 and Bend will have the largest growth in population, with the unincorporated county growing, but at a slower rate than the cities. The unincorporated county growth rate slows notably in the more distant future (2043-2068).

Table C-2 Historical Population, Population Forecast, and Average Annual Growth Rate for Deschutes County Cities

	Historical			Forecast					
	2000	2010	AAGR (2000-2010)	2018	2043	2068	AAGR (2010-2018)	Percent Change	Percent Change
Deschutes County	115,367	157,733	3.2%	187,621	301,999	432,930	2.1%	1.9%	0.7%
Bend	52,163	77,010	4.0%	91,373	162,362	255,291	2.1%	2.3%	1.8%
La Pine	899	1,653	6.3%	1,833	3,594	5,894	1.3%	2.7%	2.0%
Redmond	15,524	26,508	5.5%	29,364	51,625	82,575	1.2%	2.3%	1.9%
Sisters	961	2,038	7.8%	2,691	5,169	8,431	3.4%	2.6%	2.0%
Outside UGBs	45,820	50,524	1.0%	62,360	79,249	80,739	2.6%	1.0%	0.1%

Source: Portland State University, Population Research Center, Deschutes County Coordinated Population Forecast 2018-2068.

Urban and rural growth patterns can impact how agencies, cities and counties prepare for emergencies, because changes in development can increase risk associated with hazards. The table below shows urbanization trends in Deschutes County. Deschutes County is becoming more urban, as growth in the unincorporated county slows.

¹⁰ Portland State University Population Research Center, 2019 Annual Oregon Population Report Tables.

¹¹ Portland State University Population Research Center, Deschutes County Final Forecast Tables, accessed January 2021.

Table C-3 Urban and Rural Populations, Larger Sub-Areas 2018-2068

	2018	2043	2068	AAGR (2018-2043)	AAGR (2043-2068)	Share of County 2018	Share of County 2043	Share of County 2068
<i>Deschutes County</i>	187,621	301,999	432,930	1.9%	1.5%	-	-	-
Bend	91,373	162,362	255,291	2.3%	1.8%	48.7%	53.8%	59.0%
Redmond	29,364	51,625	82,575	2.3%	1.9%	15.7%	17.1%	19.1%
Outside UGBs	62,360	79,248	80,739	1.0%	0.1%	33.2%	26.2%	18.6%

Table C-3B Urban and Rural Populations, Smaller Sub-Areas 2018-2068

	2018	2043	2068	AAGR (2018-2043)	AAGR (2043-2068)	Share of County 2018	Share of County 2043	Share of County 2068
<i>Deschutes County</i>	187,621	301,999	432,930	1.9%	1.5%	-	-	-
La Pine	1,833	3,594	5,894	2.7%	2.0%	1.0%	1.2%	1.4%
Sisters	2,691	5,169	8,431	2.6%	2.0%	1.4%	1.7%	1.9%
Outside UGBs	62,360	79,248	80,739	1.0%	0.1%	33.2%	26.2%	18.6%

Source: Portland State University, Population Research Center, Deschutes County Coordinated Population Forecast 2018-2068.

Population size itself is not an indicator of vulnerability. More important is the location, composition, and capacity of the population within the community. Research by social scientists demonstrates that human capital indices such as language, race, age, income, education and health can affect the integrity of a community. Therefore, these human capitals can impact community resilience to natural hazards. As an example, Deschutes County’s trend towards urbanization suggests that the population may be becoming less self-reliant and more reliant on external goods and services.

Tourists

Tourists are not counted in population statistics; and are therefore considered separately in this analysis. According to surveys conducted by Visit Bend, tourism activities in Deschutes County are largely centered on outdoor activities, touring, and special events, with the majority of trips occurring during the late spring and throughout the summer.¹² Visit Bend also noted the increasing popularity of “alternative lodging”— that is, condos, townhouses, houses, and vacation rentals such as Airbnb. For hazard preparedness and mitigation purposes, outreach to residents in Deschutes County will likely be transferred to these visitors in some capacity. Visitors staying at hotels/motels are less likely to benefit from local preparedness outreach efforts aimed at residents.

Tourists are specifically vulnerable due to the difficulty of locating or accounting for travelers within the region. Tourists are often at greater risk during a natural disaster because of unfamiliarity with evacuation routes, communication outlets, or even the type of hazard that may occur. Knowing whether the region’s visitors are staying in friends/relatives homes in hotels/motels, or elsewhere can be instructive when developing outreach efforts.¹³

¹² <https://www.visitbend.com/wp-content/uploads/2018/03/Visit-Bend-Summer-2017-Final-Report.pdf>

¹³ MDC Consultants (n.d.). When Disaster Strikes – Promising Practices. Retrieved March 18, 2014, from <http://www.mdcinc.org/sites/default/files/resources/When%20Disaster%20Strikes%20-%20Promising%20Practices%20-%20Tourists.pdf>

Language

Special consideration should be given to populations who do not speak English as their primary language. Language barriers can be a challenge when disseminating hazard planning and mitigation resources to the general public, and it is less likely they will be prepared if special attention is not given to language and culturally appropriate outreach techniques.¹⁴

There are various languages spoken across Deschutes County; the primary language is English. Overall, 1.6% of the total population in Deschutes County is not proficient in English. The table below shows that while the county as a whole has a better English proficiency level than the state. Sisters and La Pine have the highest percentage of residents who do not speak English “very well”. Outreach materials used to communicate with, plan for, and respond to non-English speaking populations, and those who do not speak English very well, should take into consideration the language needs of these populations.

Table C-4 Deschutes County Language Barriers

	Speak English less than "very well"	
	Estimate	Percent
Oregon	204,308	5.10%
Deschutes	3,116	1.60%
Bend	1,677	1.90%
La Pine	107	4.90%
Redmond	1,152	4.10%
Sisters	123	4.90%

Source: U.S. Census Bureau 2019. 2019 American Community Survey 5-Year Estimates. Table DP02

Race

The impact in terms of loss and the ability to recover may also vary among minority population groups following a disaster. Studies have shown that racial and ethnic minorities can be more vulnerable to natural disaster events. This is not reflective of individual characteristics; instead, historic patterns of inequality along racial or ethnic divides have often resulted in minority communities that are more likely to have inferior building stock, degraded infrastructure, or less access to public services. The table below describes Deschutes County’s population by race and ethnicity.

The majority of the population in Deschutes County is racially white (92.1%). Approximately 8% of the population is ethnically Hispanic or Latino. It is important to identify specific ways to support all portions of the community through hazard mitigation, preparedness, and response. Culturally appropriate, and effective outreach can include both methods and messaging targeted to diverse audiences. For example, connecting to historically disenfranchised populations through already trusted sources or providing preparedness handouts and presentations in the languages spoken by the population will go a long way to increasing overall community resilience.

¹⁴ State of Oregon Natural Hazards Mitigation Plan, Region 6 Regional Profile.

Table C-5 Deschutes Race and Hispanic or Latino Origin

Race	Deschutes	Bend	La Pine	Redmond	Sisters
Total Population	186,251	93,917	2,343	30,167	2,643
One Race	97.4%	97.0%	98.2%	96.3%	94.4%
White	92.1%	93.2%	93.5%	89.7%	91.4%
Black or African American	0.7%	0.6%	0.0%	1.4%	0.0%
American Indian and Alaska Native	1.4%	0.6%	1.6%	0.9%	1.1%
Asian	1.4%	1.1%	0.0%	0.5%	0.2%
Native Hawaiian and Other Pacific Islander	0.2%	0.2%	2.6%	0.5%	0.0%
Some Other Race	1.6%	1.3%	0.4%	3.4%	1.7%
Two or More Races	2.6%	3.0%	1.8%	3.7%	5.6%
Hispanic or Latino (of any race)	8.3%	8.00%	8.40%	12.30%	14.20%
Not Hispanic or Latino	91.70%	92.00%	91.60%	87.70%	85.80%

Source: U.S. Census Bureau, 2019 American Community Survey, Table DP05.

Age

Of the factors influencing socio demographic capacity, the most significant indicator in Deschutes County may be age of the population. As depicted in the table below, as of 2019, 19.6% of the county population is over the age of 64, a percentage that is projected to rise to 23.3% by 2035. The Deschutes County age dependency ratio¹⁵ is 57.1, which is higher than the State of Oregon, 55.4; La Pine has the highest ratio for the cities at 64.8. The age dependency ratio indicates a higher percentage of dependent aged people to that of working age; this trend is projected to continue as the county population ages.

Table C-6 Deschutes Population by Vulnerable Age Groups

2019	Total	< 15 Years		>64 Years		15-64	Age Dependency Ratio
		Number	Percent	Number	Percent		
Oregon	4,266,186	721,886	16.90%	799,114	18.70%	2,745,186	55.4
Deschutes	186,251	31,269	16.80%	36,450	19.60%	118,532	57.1
Bend	93,917	17,287	18.40%	15,660	16.70%	60,970	54
La Pine	2343	317	13.50%	604	25.80%	1422	64.8
Redmond	30,167	5751	19.00%	4776	15.80%	19,640	53.6
Sisters	2643	427	16.20%	476	18.00%	1740	51.9
2035							
Oregon	4,925,420	726625	14.80%	1107124	22.50%	3091670	59.3
Deschutes	266840	40261	15.10%	62221	23.30%	164356	62.4

Source: U.S. Census Bureau, American Community Survey 2019 5-Year Estimates Table S0101; Portland State University Population Research Center, Population Forecasts. Deschutes County Final Forecast Tables. Accessed January 2021.

The age profile of an area has a direct impact both on what actions are prioritized for mitigation and how response to hazard incidents is carried out. School age children rarely make decisions about emergency management. Therefore, a larger youth population in an area will increase the importance of outreach to schools and parents on effective ways to teach children about fire safety, earthquake response, and evacuation plans. Furthermore, children are more vulnerable to the heat and cold, have few transportation options and require assistance to access medical

¹⁵ The age dependency ratio is derived by dividing the combined under 15 and 65-and-over populations by the 15-to-64 population and multiplying by 100. A number close to 50 indicates about twice as many people are of working age than non-working age. A number that is closer to 100 implies an equal number of working age population as non-working age population. A higher number indicates greater sensitivity.

facilities.¹⁶ Older populations may also have special needs prior to, during and after a natural disaster. Older populations may require assistance in evacuation due to limited mobility or health issues. Additionally, older populations may require special medical equipment or medications, and can lack the social and economic resources needed for post-disaster recovery.¹⁷

Gender

The concepts of sex and gender are often used interchangeably but are distinct; sex is based on biological attributes (chromosomes, anatomy, hormones) and gender is a social construction that may differ across time, cultures, and among people within a culture (U.S. Census Bureau, 2019, Apr. 3). Moreover, the two may or may not correspond (U.S. Census Bureau, 2019, Apr. 3).¹⁸ Deschutes County has slightly more females than males (Male: 49.7%, Female 50.3%), which is a similar ratio to that of the state.¹⁹ It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities.²⁰

Household Composition

Those living alone have the potential to be more vulnerable to natural hazards for a variety of reasons, including physical and social isolation, particularly for those who are older. While Deschutes County has a lower percentage of those over 64 living alone, almost one-fifth of households in La Pine are composed of those over 64 living alone.

Table C-7 Households and Householders Living Alone

	Total Households	Householder Living Alone - Percent of Total Households	
		Any Age	>64
Oregon	1,649,352	28.10%	11.7%
Deschutes	76,528	25.40%	9.7%
Bend	39,371	28.50%	9.8%
La Pine	944	27.60%	19.2%
Redmond	11,369	25.40%	9.0%
Sisters	1,038	26.50%	14.0%

Source: U.S. Census Bureau, 2019 American Community Survey 5-Year Estimates, Table S1101

Income

Household income and poverty status are indicators of sociodemographic capacity and the stability of the local economy. Household income can be used to compare economic areas as a whole, but does not reflect how the income is divided among the area residents. The 2019

¹⁶ 2020 State of Oregon Natural Hazards Mitigation Plan, Region 6 Central Oregon Regional Profile.

¹⁷ Wood, Nathan. Variations in City Exposure and Sensitivity to Tsunami Hazards in Oregon. U.S. Geological Survey, Reston, VA, 2007.

¹⁸ 2020 Oregon Natural Hazards Mitigation Plan

¹⁹ U.S. Census Bureau. American Community Survey 2019 1-Year Estimates Data Profiles.

²⁰ Ibid.

median household income across Deschutes County is \$67043; this is higher than the State of Oregon median income of \$62818.

Table C-8 Median Household Income

2019	
Oregon	\$62,818
Deschutes	\$67,043
Bend	\$65,662
La Pine	\$37,991
Redmond	\$65,088
Sisters	\$60,318

Source: U.S. Census Bureau, 2019 American Community Survey 5-Year Estimates, Table DP03.

The table below identifies the percentage of individuals and children under 18 that are below the poverty level in 2019. It is estimated that 13.1% of individuals and 18.3% of children under 18 live below the poverty level across the county. Poverty rates in Deschutes County are lower than that of Oregon State. La Pine and Redmond have rates that are slightly higher than the county rates for the same two categories.

Table C-9 Poverty Rates

	Population in Poverty		Under-18 Population in Poverty	
	Number	Percent	Number	Percent
Oregon	470,643	11.4%	110,323	13.10%
Deschutes	19,054	9.7%	4,879	12.90%
Bend	10,214	10.2%	2,233	10.70%
La Pine	389	16.8%	93	22.70%
Redmond	3,623	12.1%	1,228	18.50%
Sisters	310	11.7%	48	8.30%

Source: U.S. Census Bureau, 2019 American Community Survey, Table S1701.

Cutter’s research suggests that lack of wealth contributes to social vulnerability because individual and community resources are not as readily available. Affluent communities are more likely to have both the collective and individual capacity to more quickly rebound from a hazard event, while impoverished communities and individuals may not have this capacity –leading to increased vulnerability. Wealth can help those affected by hazard incidents to absorb the impacts of a disaster more easily. Conversely, poverty, at both an individual and community level, can drastically alter recovery time and quality.²¹

Federal assistance programs such as food stamps are another indicator of poverty or lack of resource access. Statewide social assistance programs like the Supplemental Nutritional Assistance Program (SNAP) and Temporary Assistance for Needy Families (TANF) provide assistance to individuals and families. In Deschutes County, approximately 6100 households had

²¹ Cutter, S. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*.

received SNAP in 2019, which is 8 percent of the population.²² Those reliant on federal assistance are more vulnerable in the wake of disaster because of a lack of personal financial resources and reliance on government support.

Education

Educational attainment of community residents is also identified as an influencing factor in socio demographic capacity. Educational attainment often reflects higher income and therefore higher self-reliance. Widespread educational attainment is also beneficial for the regional economy and employment sectors as there are potential employees for professional, service and manual labor workforces. An oversaturation of either highly educated residents or low educational attainment can have negative effects on the resiliency of the community.

According to the U.S. Census, 93.7% of the Deschutes County population over 25 years of age has graduated from high school or received a high school equivalency, with approximately 35% going on to earn a Bachelor’s Degree. La Pine has the lowest rate of high school graduates. Bend and Sisters have the highest percentages of their populations with a Bachelor’s degree or higher. Conversely, La Pine and Redmond have significantly lower percentages of their populations that have Bachelor’s degrees or higher.

Table C-10 Educational Attainment 2019

	Oregon	County	Bend	La Pine	Redmond	Sisters
Population 25 Years and Older						
Less than 9th grade	3.30%	2.20%	2.00%	5.00%	2.70%	1.60%
9th to 12th grade, no diploma	5.40%	4.50%	3.20%	9.40%	9.80%	6.70%
High school graduate or GED	23.00%	18.90%	16.20%	34.50%	27.50%	16.50%
Some college, no degree	24.80%	24.40%	21.20%	24.50%	29.30%	24.00%
Associate's degree	9.00%	11.10%	11.40%	12.40%	12.10%	16.90%
Bachelor's degree	21.00%	23.60%	27.60%	8.90%	13.00%	23.00%
Graduate or professional degree	13.50%	15.10%	18.40%	5.30%	5.60%	11.20%

Source: U.S. Census Bureau, 2019 American Community Survey, Table DP02.

Health

Individual and community health play an integral role in community resiliency, as indicators such as health insurance, people with disabilities, dependencies, homelessness and crime rate paint an overall picture of a community’s well-being. These factors translate to a community’s ability to prepare, respond to, and cope with the impacts of a disaster.

The Resilience Capacity Index recognizes those who lack health insurance or are impaired with sensory, mental or physical disabilities, have higher vulnerability to hazards and will likely require additional community support and resources. The percentage of the population in Deschutes County without health insurance is similar to that of the State. The percentage of uninsured changes with age, the highest rates of uninsured are within the 18 to 64 year category; La Pine has the highest rate of this age group that is uninsured. Overall the county has a lower percentage of people under age 18 that are uninsured than Oregon; Redmond and

²² U.S. Census, American Community Survey, 2019 5-Year Estimates, Table S2201.

Sisters have the highest rate of this age group that is uninsured. The ability to provide services to the uninsured populations may burden local providers following a natural disaster.

Table C-11 Health Insurance Coverage

Jurisdiction	Total Population	Population without Health Insurance			
		Total Population	Under 18	18-64	65+
Oregon	4,266,186	7.20%	4.10%	10.30%	0.60%
Deschutes	186,251	7.00%	2.50%	11.00%	0.00%
Bend	93,917	9.00%	3.70%	13.10%	0.00%
La Pine	2343	14.70%	0.00%	25.00%	2.20%
Redmond	30,167	7.70%	6.40%	10.10%	0.40%
Sisters	2643	10.10%	10.90%	12.80%	0.00%

Source: U.S. Census Bureau, 2019 American Community Survey 5-Year Estimates, Table S2701.

The table below describes disability status of the population. As of 2012, 12.6% of the Deschutes County population, 23,296 people, identifies with one or more disabilities; this rate is below the State percentage. La Pine has the highest percentage of its total population with a disability (21.0%) and also the highest percentage of individuals 65 years and over with a disability (45%). The county’s percentage of individuals under 18 years with a disability (3.9%) is lower than the state percentage.

Table C-12 Deschutes County Disability Status

	Total Population	Total Population with a Disability	Under 18 Population with a Disability	65+ Population with a Disability
Oregon	4,266,186	14.40%	4.60%	35.70%
Deschutes	186,251	12.60%	3.90%	29.50%
Bend	93,917	10.40%	2.90%	28.40%
La Pine	2343	21.00%	2.20%	45.00%
Redmond	30,167	13.70%	7.20%	34.70%
Sisters	2643	12.20%	0.90%	22.70%

Source: U.S. Census Bureau, 2008-2012 American Community Survey, Table DP02.

According to a point-in-time (PIT) study of homelessness conducted by Oregon Housing and Community Services (OHCS) in 2019, there are 700 homeless individuals identified in the county, 109 of them children.²³ The homeless have few resources to rely on, especially during an emergency. It will likely be the responsibility of the county and local non-profit entities to provide services such as shelter, food and medical assistance. Therefore, it is critical to foster collaborative relationships with agencies that will provide additional relief such as the American Red Cross and homeless shelters. It will also be important to identify how to communicate with

²³ Oregon Housing and Community Services, “2019 Point in Time Homeless Count”.
<https://public.tableau.com/profile/oregon.housing.and.community.services#!/vizhome/2019Point-in-TimeDashboard/Story1>

these populations, since traditional means of communication may not be appropriate or available.

Synthesis

For planning purposes, it is essential Deschutes County consider both immediate and long-term socio-demographic implications of hazard resilience. Immediate concerns include the growing elderly population and language barriers associated with a culturally diverse community. Even though the vast majority of the population is reported as proficient in English, there is still a small amount of the population not proficient in English. These populations would serve to benefit from mitigation outreach, with special attention to cultural, visual and technology sensitive materials. The current status of other Social/-demographic capacity indicators such as graduation rate, quality of schools, high violent crime rate, and poverty level higher and median household income lower than the State can have long-term impacts on the economy and stability of the community ultimately affecting future resilience.

Economic Capacity

Economic capacity refers to the financial resources present and revenue generated in the community to achieve a higher quality of life. Income equality, housing affordability, economic diversification, employment and industry are measures of economic capacity. However, economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how the component parts of employment sectors, workforce, resources and infrastructure are interconnected in the existing economic picture. Once any inherent strengths or systematic vulnerabilities become apparent, both the public and private sectors can take action to increase the resilience of the local economy.

Regional Affordability

The evaluation of regional affordability supplements the identification of Social/demographic capacity indicators, i.e. median income, and is a critical analysis tool to understanding the economic status of a community. This information can capture the likelihood of individuals' ability to prepare for hazards, through retrofitting homes or purchasing insurance. If the community reflects high-income inequality or housing cost burden, the potential for homeowners and renters to implement mitigation can be drastically reduced. Therefore, regional affordability is a mechanism for generalizing the abilities of community residents to get back on their feet without Federal, State or local assistance.

Income Equality

Income equality is a measure of the distribution of economic resources, as measured by income, across a population. It is a statistic defining the degree to which all persons have a similar income. The table below illustrates the county and cities level of income inequality. The Gini index is a measure of income inequality. The index varies from zero to one. A value of one indicates perfect inequality (only one household has any income). A value of zero indicates perfect equality (all households have the same income).²⁴

Deschutes County's income distribution is approximately reflective of the State as a whole. The cities within the county vary slightly with the greatest income equality within the city of Redmond. Based on social science research, the region's cohesive response to a hazard event may be affected by the distribution of wealth in communities that have less income equality.²⁵

²⁴University of California Berkeley. Building Resilient Regions, Resilience Capacity Index. <http://brr.berkeley.edu/rci/>.

²⁵Susan Cutter, Christopher G. Burton, and Christopher T. Emrich. 2010. "Disaster Resilience Indicators for Benchmarking Baseline Conditions," *Journal of Homeland Security and Emergency Management* 7, no.1: 1-22

Table C-13 Regional Income Equality

Jurisdiction	Income Inequality Coefficient
Oregon	0.450
Deschutes	0.439
Bend	0.452
La Pine	0.466
Redmond	0.371
Sisters	0.448

Source: U.S. Census Bureau, 2019 American Community Survey, Table B19083.

Housing affordability is a measure of economic security gauged by the percentage of an area’s households paying less than 35% of their income on housing.²⁶ Households spending more than 35% are considered housing cost burdened. The table below displays the percentage of homeowners and renters reflecting housing cost burden across the region.

In comparison to the State, Deschutes County has a greater percentage of homeowners with a mortgage spending more than 35% of their income on housing. Among homeowners without a mortgage, Sisters has the greatest rate of households with housing cost burdens. Amongst homeowners with a mortgage, Sisters and Redmond have the highest rates of housing cost burden. Among renters, La Pine, Bend, and Sisters residents have the greatest rates of households with housing cost burdens. In general, the population that spends more of their income on housing has proportionally fewer resources and less flexibility for alternative investments in times of crisis.²⁷ This disparity imposes challenges for a community recovering from a disaster as housing costs may exceed the ability of local residents to repair or move to a new location. These populations may live paycheck to paycheck and are extremely dependent on their employer, in the event their employer is also impacted it will further the detriment experienced by these individuals and families.

Table C-14 Households Spending > 35% of Income on Housing

Jurisdiction	Owners		Renters
	With Mortgage	Without Mortgage	
Oregon	22.70%	11.50%	41.70%
Deschutes	26%	10.0%	41.70%
Bend	25%	9.7%	42.30%
La Pine	20%	10.4%	43.50%
Redmond	26%	9.3%	39.50%
Sisters	33%	11.6%	46.00%

Source: U.S. Census Bureau, 2019 American Community Survey, Table DP04.

Economic Diversity

Economic diversity is a general indicator of an area’s fitness for weathering difficult financial times. One method for measuring economic diversity is through use of the Hachman Index, a

²⁶ University of California Berkeley. Building Resilient Regions, Resilience Capacity Index. <http://brr.berkeley.edu/rci/>.

²⁷ Ibid.

formula that compares the composition of county and regional economies with those of states or the nation as a whole. Using the Hachman Index, a diversity ranking of 1 indicates the Oregon County with the most diverse economic activity compared to the state as a whole, while a ranking of 36 corresponds with the least diverse county economy. Deschutes County ranked 4th out of the 36 counties in the state overall. The table below describes the Hachman Index Scores for counties in the region.

Table C-15 Regional Hachman Index Scores

County	2019 Index Value
Crook County	0.378
Jefferson County	0.142
Deschutes County	0.789
Klamath County	0.555
Lake County	0.062
Wheeler County	0.109

Source: Oregon Employment Department

While illustrative, economic diversity is not a guarantor of economic vitality or resilience. A measure of “economic distress” is based on indicators of decreasing new jobs, average wages and income, and is associated with an increase of unemployment.²⁸ In the previous issue of this NHMP, Deschutes County was listed as “economically distressed” by the Oregon Business Development Commission; however, as of the latest analysis at the end of 2020, Deschutes County is no longer considered economically distressed.

Employment and Wages

According to the Oregon Employment Department, unemployment has declined since 2016, until the COVID-19 pandemic drastically impacted businesses and jobs nationwide.

Table C-16 Unemployment Rates in Region 6 (Seasonally Adjusted)

	2016	2017	2018	2019	2020
Oregon	4.80%	4.10%	4.10%	3.70%	8.00%
Crook	6.90%	6.30%	5.90%	5.30%	9.70%
Jefferson	6.60%	5.60%	5.40%	5.10%	8.90%
Deschutes	4.90%	4.20%	4.10%	3.90%	8.60%
Klamath	6.80%	5.90%	6.20%	6.20%	9.20%
Lake	6.40%	5.70%	5.50%	5.40%	5.90%
Wheeler	4.20%	4.00%	3.30%	4.30%	4.40%

Source: Oregon Employment Department, “Local Area Employment Statistics”.
<http://www.qualityinfo.org/olmisj/labforce>. Accessed January 2021.

²⁸ Business Oregon – Oregon Economic Data “Distressed Communities List”,
<http://www.oregon4biz.com/Publications/Distressed-List/>

The table below displays the average annual wage for Deschutes County and the region. As of 2019, the average wage was \$47,595 in Deschutes County, which is the highest in the region.

Table C-17 Regional Average Pay

	Average Pay 2019
Crook County	\$46,356
Deschutes County	\$47,595
Jefferson County	\$40,436
Klamath County	\$40,136
Lake County	\$40,468
Wheeler County	\$31,038

Source: Oregon Employment Department, 2019 Wages Summary Report".
<http://www.qualityinfo.org/olmisj/labforce>. Accessed January 2021.

In 2018, there were 7,564 employment establishments in Deschutes County of which about 6,788, or 90%, had fewer than 20 employees.²⁹ The prevalence of small businesses in Deschutes County is an indication of sensitivity to natural hazards because small businesses are more susceptible to financial uncertainty. If a business is financially unstable before a natural disaster occurs, financial losses (resulting from both damage caused and the recovery process) may have a bigger impact than they would for larger and more financially stable businesses.

Industry

Major Regional Industry

Key industries are those that represent major employers and are significant revenue generators. Different industries face distinct vulnerabilities to natural hazards, as illustrated by the industry specific discussions below. Identifying key industries in the region enables communities to target mitigation activities towards those industries' specific sensitivities. It is important to recognize that the impact that a natural hazard event has on one industry can reverberate throughout the regional economy.

This is of specific concern when the businesses belong to the basic sector industry. Basic sector industries are those that are dependent on sales outside of the local community; they bring money into a local community via employment. The farm and ranch, information, and wholesale trade industries are all examples of basic industries. Non-basic sector industries are those that

²⁹ U.S. Census Bureau, 2018 County Business Patterns (NAICS). Table CBP2018.

are dependent on local sales for their business, such as retail trade, construction, and health services.

Employment by Industry

Economic resilience to natural disasters is particularly important for the major employment industries in the region. If these industries are negatively impacted by a natural hazard, such that employment is affected, the impact will be felt throughout the regional economy. Thus, understanding and addressing the sensitivities of these industries is a strategic way to increase the resiliency of the entire regional economy.

The table below identifies Employment by industry. The top three industry sectors in Deschutes County with the most employees, as of 2019, are Trade, Transportation & Utilities, Education & Health Services), and Leisure & Hospitality. Trending towards basic industries such as these can lead to higher community resilience. The sectors of highest projected growth within Deschutes County are Education & Health Services, Construction, and Information.

Table C-18 Total Employment by Industry 2019, Expected Growth 2022

	Firms (County)	Employees (County)	Percent of Workforce	Average Pay	Employment Forecast 2019-2029 (Region)
Total Payroll Employment	9104	85372	100.00%	\$47,595	10%
Total Private	8874	75996	89.00%	\$46,568	10%
Natural Resources and Mining	124	818	1.00%	\$42,116	8%
Construction	1264	6765	7.90%	\$55,068	18%
Manufacturing	381	5655	6.60%	\$51,602	6%
Trade, Transportation & Utilities	1457	16041	18.80%	\$40,544	6%
Information	276	1790	2.10%	\$79,191	15%
Financial Activities	883	3396	4.00%	\$62,434	3%
Professional and Business Services	1666	10266	12.00%	\$55,893	12%
Education and Health Services	918	14155	16.60%	\$57,935	18%
Leisure and Hospitality	743	13560	15.90%	\$23,677	7%
Other Services	1067	3484	4.10%	\$33,516	11%
Government	229	9376	11.00%	\$55,917	7%
Federal	34	967	1.10%	\$70,855	-3%
State	39	904	1.10%	\$64,656	13%
Local	157	7504	8.80%	\$52,947	8%

Source: Oregon Employment Department, "2019 Covered Employment and Wages Summary Reports" and "East Cascades Industry Employment Projections, 2019-2029". <http://www.qualityinfo.org>. Accessed January 2021.

High Revenue Sectors

In 2007, the three sectors with the highest revenue were Health Care & Social Assistance, Retail Trade, and Manufacturing. The table below shows the revenue generated by each economic

sector (Note: not all sectors are reported, i.e., Professional, Scientific & Technical Services). All of the sectors combined generated almost \$1,256,184 billion in revenue for the County.

Deschutes County relies on both basic and non-basic sector industries and it is important to consider the effects each may have on the economy following a disaster. Basic sector businesses have a multiplier effect on a local economy that can spur the creation of new jobs, some of which may be non-basic. The presence of basic sector jobs can help speed the local recovery; however, if basic sector production is hampered by a natural hazard event, the multiplier effect could be experienced in reverse. In this case, a decrease in basic sector purchasing power results in lower profits and potential job losses for the non-basic businesses that are dependent on them.³⁰

Future Employment in Industry

Sectors that are anticipated to be major employers in the future also warrant special attention in the hazard mitigation planning process. Between 2019 and 2029, the largest employment growth is anticipated within Construction (18%) and Private Educational and Health Services (18%).³¹ Information is expected to increase by 15% while Profession and Business Services is expected to increase by 12%.

Synthesis

The current and anticipated financial conditions of a community are strong determinants of community resilience, as a strong and diverse economic base increases the ability of individuals, families and the community to absorb disaster impacts for a quick recovery. Because the Health and Social Assistance industry as well as the Government sector are key to post-disaster recovery efforts, the region is bolstered by its major employment sectors. The county is expected to grow at a high rate over the next 10 years with much of the growth within the healthcare and construction industries.³² It is important to consider what might happen to the county economy if the largest revenue generators and employers are impacted by a disaster.

Built Environment Capacity

Built Environment capacity refers to the built environment and infrastructure that supports the community. The various forms, quantity, and quality of built capital mentioned above contribute significantly to community resilience. Physical infrastructures, including utility and transportation lifelines, are critical during a disaster and are essential for proper functioning and response. The lack or poor condition of infrastructure can negatively affect a community's ability to cope, respond and recover from a natural disaster. Following a disaster, communities may

³⁰ State of Oregon Natural Hazards Mitigation Plan, Region 6 Central Oregon Regional Profile.

³¹ Oregon Employment Department, "East Cascades Industry Employment Projections, 2019-2029", <http://qualityinfo.org/>, accessed January 2021.

³² State of Oregon Natural Hazards Mitigation Plan, Region 6 Central Oregon Regional Profile

experience isolation from surrounding cities and counties due to infrastructure failure. These conditions force communities to rely on local and immediately available resources.

Land Use and Development Patterns

The majority of the county has a low population density. Sixty-six percent of the population resides in the four incorporated cities. Three of the incorporated cities are located in the northern half of the county and one is located in the southern half. The majority of land (about 80% of 1,529,522 acres) in Deschutes County is publicly owned (76.6% Federal Government, 2.8% State Government, 0.6% County Government); the remaining lands are owned privately.³³ About 91% of the county lies within the Deschutes Basin, which covers 10,000 square miles throughout Central Oregon. Other land uses include agriculture and surface mining.³⁴ Wildfires pose a threat for the forested areas of the high desert Western ecosystem; of particular concern are the areas within the Wildland-Urban Interface.

According to the State Natural Hazards Mitigation Plan (2020):

Development pressure has been high in the Bend, Sisters, and Redmond areas in the past few decades. Between 1974 and 2009, the Bend area lost 13 percent of its land in resource land uses to more developed uses. However, since 1984 that rate has declined - annual average rates of conversion of land in resource land uses to low-density or urban uses in Deschutes County was 88 percent less in the 2005-2009 period when compared to the 1974-1984 period. Similar trends, although less pronounced, are seen in Klamath County....[between 2009 and 2014] the percentage of resource lands converted in each county in Region 6 was less than one percent of each county's total acreage. The majority of conversion during this period occurred in Crook and Deschutes Counties.

Responding to rapid growth and changing demographics, in 2011 Deschutes County completed a multi-year effort to establish the 2030 Comprehensive Plan Update (Plan 2030). This new plan incorporates updated goals and policies, community plans, and new projects like the South County Plan, destination resort remapping, a 2030 Transportation System Plan, and a South County Local Wetland Inventory.³⁵ Deschutes County is beginning a new Transportation System Plan in 2021 and aims to begin updating its Comprehensive Plan shortly thereafter. The City of Bend adopted an updated Transportation System Plan in September 2020.

Housing

In addition to location, the characteristics of the housing stock affect the level of risk posed by natural hazards. The table below identifies the types of housing most common throughout the county. Of particular interest are mobile homes, which account for about 6.8% of the housing in Deschutes County. Mobile homes are particularly vulnerable to certain natural hazards, such as windstorms, and special attention should be given to securing the structures, because they are more prone to wind damage than wood-frame construction.³⁶ In other natural hazard events, such as earthquakes and floods, moveable structures like mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants. La Pine (10.2%) has a

³³ Deschutes County Comprehensive Plan. 2011.

³⁴ Ibid.

³⁵ Department of Land Conservation and Development, Oregon Natural Hazards Mitigation Plan Effective September 24, 2020 and Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

³⁶ Ibid.

higher percentage of mobile structures than other parts of the county; while Bend (2,298) and Redmond (540) have the greatest number.

Table C-19 Housing Profile

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,768,901	1202443	68.00%	421015	23.80%	140,183	7.9
Deschutes	88,714	69436	78.20%	13072	14.80%	6036	6.80%
Bend	41,926	31042	74.00%	8530	20.40%	2298	5.50%
La Pine	1,030	791	76.80%	113	11.10%	105	10.20%
Redmond	11,636	8991	77.30%	2089	18.00%	540	4.60%
Sisters	1,318	1004	76.20%	254	19.20%	60	4.60%

Source: U.S. Census Bureau, 2019 American Community Survey, Table DP04.

Aside from location and type of housing, the year structures were built has implications. Seismic building standards were codified in Oregon building code starting in 1974; more rigorous building code standards were passed in 1993 that accounted for the Cascadia earthquake fault.³⁷ Therefore, homes built before 1993 are more vulnerable to seismic events. Also in the 1970's, FEMA began assisting communities with floodplain mapping as a response to administer the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. The table below illustrates the number and percent of homes built between 1970 and 2019. Within Deschutes County approximately 10% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. Countywide, approximately 40% of the housing stock was built before 1990 and the codification of seismic building standards. Approximately 60% of the county's housing stock was built after 1990 (Redmond and Sisters have about two-thirds or more of their housing units built after 1990).

Table C-20 Year Structure Built

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,768,901	596,219	33.70%	532,466	30.10%	640,216	36.20%
Deschutes	88,714	9,052	10.20%	26,540	29.90%	53,122	59.90%
Bend	41,926	4,268	11.10%	11,240	26.80%	26,058	62.10%
La Pine	1,030	216	21.10%	215	20.90%	599	58.20%
Redmond	11,636	1,751	15%	2,315	19.90%	7,570	65.10%
Sisters	1,318	94	7.20%	222	16.80%	1002	76.10%

Source: U.S. Census Bureau, 2019 American Community Survey, Table DP04.

As table C-20 indicates, the majority of the housing stock is single-family homes, a trend that is continuing with new construction. The table below shows the percent growth of the region's housing units in urban areas between 2000 and 2010 (40.7%) is almost twice the percent growth

³⁷ State of Oregon Building Codes Division. *Earthquake Design History: A summary of Requirements in the State of Oregon*, February 7, 2012. http://www.oregon.gov/OMD/OEM/osspac/docs/history_seismic_codes_or.pdf

in rural areas (21.2%). Deschutes County gained the most urban housing units (approximately 21,150) and had the highest growth rate in urban housing (69.0%).

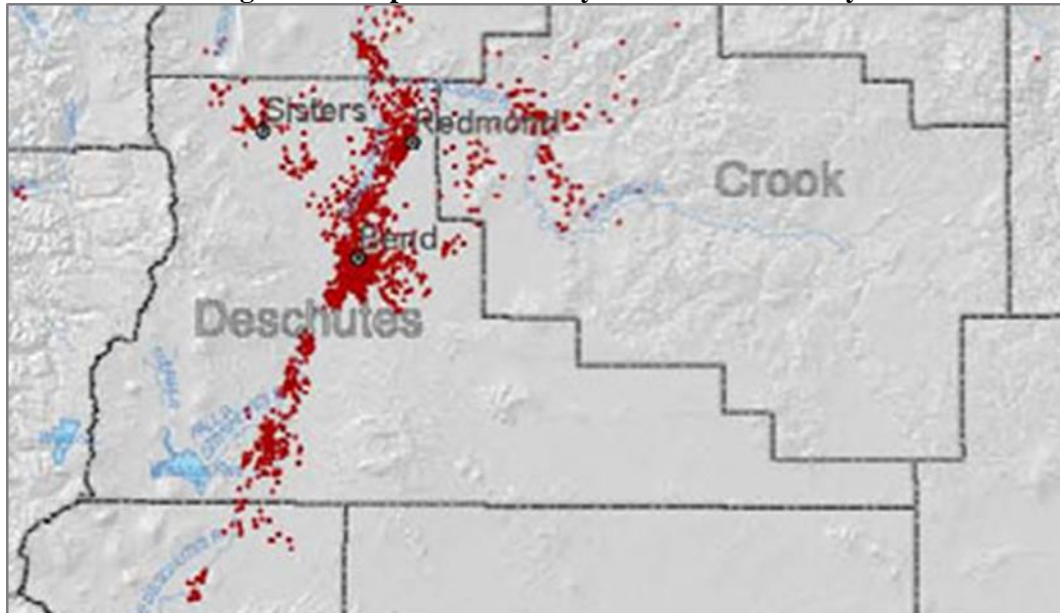
Table C-21 Urban and Rural Housing Units in Region 6

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 6	57,098	80,325	40.7%	47,792	57,939	21.2%
Crook	4,190	4,884	16.6%	4,074	5,318	30.5%
Deschutes	30,684	51,844	69.0%	23,899	28,295	18.4%
Jefferson	2,735	3,382	23.7%	5,584	6,433	15.2%
Klamath	17,950	18,684	4.1%	10,933	14,090	28.9%
Lake	1,539	1,531	-0.5%	2,460	2,908	18.2%
Wheeler	0	0	-	842	895	6.3%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 & 2010 Decennial Census, Table H2

The figure below shows population density in Deschutes County. The area’s population is clustered around the Highway 20 and 97 corridors and the cities of Bend, La Pine, Redmond, and Sisters. In addition to the county’s incorporated cities there are also significant populations in the resort communities of Black Butte Ranch and Sunriver; the populations in these two communities are significantly higher during summer than winter.

Figure C-4 Population Density in Deschutes County



Source: Integrated Water Resources Strategy: 2010 Open House Map Gallery, Water Resources Department, State of Oregon

The National Flood Insurance Program’s (NFIP’s) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized. The table below shows the initial and current FIRM effective dates for Deschutes County communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the Flood Hazard Chapter and Risk Assessment (Volume II).

Table C-22 Community Flood Map History

	Initial FIRM	Current FIRM
Deschutes	August 16, 1988	September 28, 2007
Bend	September 4, 1987	September 28, 2007
La Pine	September 28, 2007	September 28, 2007
Sisters	September 29, 1986	September 28, 2007

Source: Federal Emergency Management Agency, Community Status Book Report;
(M) – No elevation determined, All Zone A, C and X

Other Development

Critical Facilities

Critical facilities are those facilities that are essential to government response and recovery activities (e.g., hospitals, police, fire and rescue stations, school districts and higher education institutions). The interruption or destruction of any of these facilities would have a debilitating effect on incident management.

Critical facilities in Deschutes County are identified in the table below. Lifelines and other physical infrastructure, such as transmission lines, power generation facilities, levees and dams are critical, further information can be obtained in the “lifelines” subsection. This information provides the basis for informed decisions about the infrastructure and facilities already in place that can be used to reduce the vulnerability of the county to natural hazards.

Table C-23 Deschutes County Critical Facilities

	Hospitals			Law Enforcement	Fire and Rescue Stations	School Districts*	Universities and Colleges
	# Hospitals	# Beds	Trauma Level				
Deschutes	2	297	-	4	8	3	2
Bend	1	249	2	2	2	1	2
La Pine	0	-	-	0	1	1	0
Sisters	0	-	-	0	2	1	0
Redmond	1	48	3	1	1	1	0

Source: Oregon Association of Hospitals and Health Systems, 2020 Oregon Community Hospital Report, <https://oahhs.org/public-resources/2020-oregon-community-hospital-report.html>; Deschutes County District Attorney; Oregon State Police Oregon Office of State Fire Marshal, “Fire Department List” <https://www.oregon.gov/osp/programs/sfm/Pages/Fire-Agency-Contact-List.aspx>; Oregon Department of Education, “Education Institutions”, <http://www.osba.org/Links/LeftNav/Education%20Institutions.aspx>. Accessed April 2021.

Dependent Facilities

In addition to the critical facilities mentioned above in the table above, there are other facilities that are vital to the continued delivery of health services and may significantly impact the public's ability to recover from emergencies. Assisted living centers, nursing homes, residential mental health facilities, and psychiatric hospitals are important to identify within the community because of the dependent nature of the residents; and also these facilities can serve as secondary medical facilities as they are equipped with nurses, medical supplies and beds.

Deschutes County has approximately 28 facilities that provide services for assisted living, retirement, and nursing homes; in addition there are three residential mental health or substance abuse facilities³⁸. Saint Charles Medical Group, located in Bend, is the only inpatient psychiatric facility east of the Cascades. Most of the dependent facilities are located within Bend; however, a few are located in Redmond.

Correctional Facilities

Correctional facilities are incorporated into physical infrastructure as they play an important role in everyday society by maintaining a safe separation from the public. There are two correctional facilities located in Deschutes County: the Deschutes County Adult Jail, located in Bend and adjacent to the sheriff's office and the Juvenile Detention Facility in Bend, which offers year-round schooling and self-improvement groups like TruThought, Skill Streaming, and drug and alcohol information.³⁹

Infrastructure Profile

Physical infrastructure such as dams, levees, roads, bridges, railways and airports support Deschutes County communities and economies. Due to the fundamental role that physical infrastructure plays both in pre and post-disaster, they deserve special attention in the context of creating resilient communities.

Dams

Dam failures can occur rapidly and with little warning. Fortunately, most failures result in minor damage and pose little or no risk to life safety. However, the potential for severe damage still exists. The Oregon Water Resources Department has inventoried all dams located in Oregon and Deschutes County. There are five dams categorized as high hazard; North Canal Diversion, Crescent Lake, Crane Prairie Dam, Wickiup Dam, and the Sunriver Effluent Lagoon. In addition, the moraine lake dam on Whychus Creek (Carver Lake) above Sisters is identified as a potential flood concern, particularly with respect to impacts to the City of Sisters Wastewater Treatment Facility. (See Flood Hazard Annex and Sisters Addendum in Volume III for more information)

³⁸ Oregon Care Planning Council, <http://www.carefororegon.org/>

³⁹ Deschutes County Detention, <https://www.deschutes.org/justice/page/detention-facility>.

Table C-24 Deschutes County Dam Inventory

Dam Name	River	Last Inspection	Next Inspection	Hazard
North Canal Diversion	Deschutes River	8/26/2019	2020	High
Crescent Lake	Deschutes River	9/10/2019	2020	High
Crane Prairie Dam	Deschutes River	7/7/2020	2021	High
Wickiup Dam	Deschutes River	8/20/2020	2021	High
Sunriver Effluent Lagoon	Off Channel	9/10/2019	2020	High
Fehrenbacher Reservoir 2	Dry River	8/11/2016	2022	Low
Upper Tumalo Reservoir	Tumalo Creek	2/14/2020	2026	Low
Squaw Creek Id Reservoir	Squaw Creek	2/19/2020	2026	Low
Cyrus Reservoir	Squaw Creek	2/18/2020	2026	Low
(Lagoon)	Effluent	7/23/2015	2021	Low
Bradetich Reservoir	Off Channel	8/6/2015	2021	Low
Eagle Crest	Off Channel	8/24/2017	2023	Low
Mckenzie Canyon Dam	Squaw Creek	7/18/2018	2021	Significant
Bend Hydro (Mirror Pond)	Deschutes River	8/26/2019	2022	Significant
Sparks	Off Channel	No Data	No Data	Significant

Source: Oregon water Resources Department, "Dam Inventory Query", http://apps.wrd.state.or.us/apps/misc/dam_inventory/, Accessed January 2021.

Railroads

Railroads are major providers of regional and national cargo trade flows. The region's major (Class I) freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. The Burlington Northern Santa Fe Railway runs through Deschutes County and along the Oregon Washington border.

Amtrak provides passenger rail service from the Willamette Valley south through Klamath County and southward to Los Angeles, California via the Coast Starlight line; (the nearest station is in Chemult).⁴⁰

Rails are sensitive to icing from winter storms that can occur in the Central Oregon region. For industries in the region that utilize rail transport, these disruptions in service can result in economic losses. The potential for rail accidents caused by natural hazards can also have serious implications for the local communities if hazardous materials are involved.

Airports

Deschutes County has four public airports, twelve private airports, and three private heliports.⁴¹ One heliport is owned by St. Charles Medical Center. Of the public airports, two are municipal airports, respectively owned and operated by the City of Bend and City of Redmond. The Redmond Municipal Airport-Roberts Field (RDM) is the only commercial airport in the region.⁴²

⁴⁰ State of Oregon Natural Hazards Mitigation Plan, Region 6 Central Oregon Regional Profile

⁴¹ FAA Airport Facilities Data. 2014.

https://www.faa.gov/airports/airport_safety/airportdata_5010/menu/contacts.cfm?Region=&District=&State=OR&County=DESCHUTES&City=&Use=&Certification= Accessed January 2021.

⁴² Redmond Airport Website, <http://www.flyrdm.com/>

The airport serves six passenger airlines (American Airlines, Alaska Air, Allegiant, Delta, United/United Express, Boutique Air) providing direct service to Denver, Las Vegas, Los Angeles, Phoenix, Portland, San Francisco, Salt Lake City, and Seattle.⁴³ Access to these facilities could become closed in the event of natural hazards. Another important consideration in identifying area air resources is the type and condition of runway surfaces at these various facilities, as they will impact the ability to utilize the airport and respond to major disasters.

Energy

Several solar power facilities have been approved and constructed in Deschutes County. Pacific Power and Light (Pacific Power) and Central Oregon Irrigation District have power generator facilities at some in-water facilities. The county is served by several investor-owned, public, and cooperative and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power is the primary investor-owned utility company serving Deschutes County. The county's electric cooperatives include Central Electric Cooperative, Midstate Electric Cooperative, and Harney Electric Cooperative.

Roads

The region's major expressways are Highway 97 and Highway 20. Highway 97 bisects the center of Deschutes County and is a main passage for automobiles and trucks traveling from states to central Oregon. It merges with Highway 26 and connects Bend with Portland, a distance of 162 miles. It also merges with Interstate-5 and connects Bend with California.

- Highway 20 runs east-west across the State and connects Deschutes County with Newport on the coast and Idaho.

Other major highways that service this region include:

- Highway 372 also known as the Cascade Lakes Scenic Byway connects Bend to the Cascade Mountains and access to recreational activities.
- Highway 126 connects coastal, western, and central parts of Oregon.

Daily, transportation infrastructure capacity in the Central Oregon region is stressed by maintenance and lack of infrastructure in some areas. For example, some county roads are too narrow for fire equipment vehicles. Additionally, natural hazards can further disrupt automobile traffic and create gridlock. This is of specific concern in periods of evacuation and there are few alternative routes, especially in remote parts of the county.⁴⁴

Bridges

Because of earthquake risk, the seismic vulnerability of the county's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The county's bridges are part of the state and interstate highway

⁴³ Ibid.

⁴⁴ State of Oregon Natural Hazards Mitigation Plan, Region 6 Central Oregon Regional Profile.

system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region’s counties and cities.

The table below shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges; the ratings do not imply that a bridge is unsafe.⁴⁵ The table shows that the county has a lower percentage of bridges that are distressed and/or deficient (14%), than does the state (21%). About 31% of the region’s county and city owned bridges are distressed, compared to 11% of ODOT bridges.

Table C-25 Bridge Inventory

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic Covered
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 6	21	144	15%	27	240	11%	8	57	14%	4	9	44%	60	449	13%	12
Deschutes	5	48	11%	8	47	17%	5	35	14%	1	4	25%	19	132	14%	2

Source: Oregon Department of Transportation, 2014; Oregon Department of Transportation (2013), Oregon’s Historic Bridge Field Guide

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Utility Lifelines

Utility lifelines are the resources that the public relies on daily, (i.e., electricity, fuel and communication lines). If these lines fail or are disrupted, the essential functions of the community can become severely impaired. Utility lifelines are closely related to physical infrastructure, (i.e., dams and power plants) as they transmit the power generated from these facilities.

Deschutes County receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. Most of the natural gas Oregon uses originates in Alberta, Canada. TransCanada owns the main natural gas transmission pipeline in Central Oregon while Cascade Natural Gas supplies the greater part of Central Oregon.⁴⁶ The electric, oil, and gas lifelines that run through the County are both municipally and privately owned.⁴⁷ The network of electricity transmission lines running through the county may be vulnerable to severe, but infrequent natural hazards, such as windstorm, winter storms, and earthquakes.

Seismic lifeline routes help maintain transportation facilities for public safety and resilience in the case of natural disasters. Following a major earthquake, it is important for response and recovery agencies to know which roadways are most prepared for a major seismic event. The Oregon Department of Transportation has identified lifeline routes to provide a secure lifeline

⁴⁵ Oregon. Bridge Engineering Section (2012). 2012 Bridge Condition Report. Salem, Oregon: Bridge Section, Oregon Department of Transportation.

⁴⁶ Ibid.

⁴⁷ Loy, W. G., Allan, S., & Patton, C. P. (1976). *Atlas of Oregon*. Eugene: University of Oregon and Economic Development for Central Oregon, retrieved from <http://www.edcoinfo.com/business-resources/utilities/natural-gas/default.aspx>

network of streets, highways, and bridges to facilitate emergency services response after a disaster.⁴⁸

System connectivity and key geographical features were used to identify a three-tiered seismic lifeline system. Routes identified as Tier 1 are considered to be the most significant and necessary to ensure a functioning statewide transportation network. The Tier 2 system provides additional connectivity to the Tier 1 system, it allows for direct access to more locations and increased traffic volume capacity. The Tier 3 lifeline routes provide additional connectivity to the systems provided by Tiers 1 and 2. The figure below shows Tiers 1, 2, and 3 seismic lifeline routes.⁴⁹

The Tier 1 system in Central Oregon consists of the following corridors:

- I-84 from the The Dalles to Biggs Junction
- US 97

There are no Tier 2 corridors in the Central Geographic Zone

The Tier 3 corridor in the Central Geographic Zone consists of:

- US 197

Synthesis

Given the unique dependent, rural nature of Deschutes County, maintaining the quality of built capacity throughout the area is critical. The planning considerations seemingly most significant for the county are contingency planning for medical resources and lifeline systems due to the imminent need for these resources. As mentioned above, functionality of hospitals and dependent care facilities are a significant priority in providing for Deschutes County residents. One factor that is critical to consider in planning is the availability of medical beds in local hospitals and dependent care facilities. In the event of a disaster, medical beds may be at a premium providing not just for the growing elderly population, but the entire county. Some of these facilities may run at almost full capacity on a daily basis, hospitals should consider medical surge planning and develop memorandums with surrounding counties for medical transport and treatment. Other facilities to consider are utility lifelines and transportation lifelines such as airports, railways, roads and bridges with surrounding counties to acquire utility service and infrastructure repair.

While these elements are traditionally recognized as part of response and recovery from a natural disaster, it is essential to start building relationships and establishing contractual agreements with entities that may be critical in supporting community resilience.

⁴⁸ CH2MHILL, Prepared for Oregon Department of Transportation. Oregon Seismic Lifeline Routes Identification Project, *Lifeline Selection Summary Report*, May 15 2012.

⁴⁹ Ibid.

Community Connectivity Capacity

Community connectivity capacity places strong emphasis on social structure, trust, norms, and cultural resources within a community. In terms of community resilience, these emerging elements of social and cultural capital will be drawn upon to stabilize the recovery of the community. Social and cultural capitals are present in all communities; however, it may be dramatically different from one city to the next as these capitals reflect the specific needs and composition of the community residents.

Social Systems and Service Providers

Social systems include community organizations and programs that provide social and community-based services, such as employment, health, senior and disabled services, professional associations and veterans' affairs for the public. In planning for natural hazard mitigation, it is important to know what social systems exist within the community because of their existing connections to the public. Often, actions identified by the plan involve communicating with the public or specific subgroups within the population (e.g. elderly, children, low income, etc.). The County can use existing social systems as resources for implementing such communication-related activities because these service providers already work directly with the public on a number of issues, one of which could be natural hazard preparedness and mitigation. The presence of these services are more predominantly located in urbanized areas of the County, this is synonymous with the general urbanizing trend of local residents.

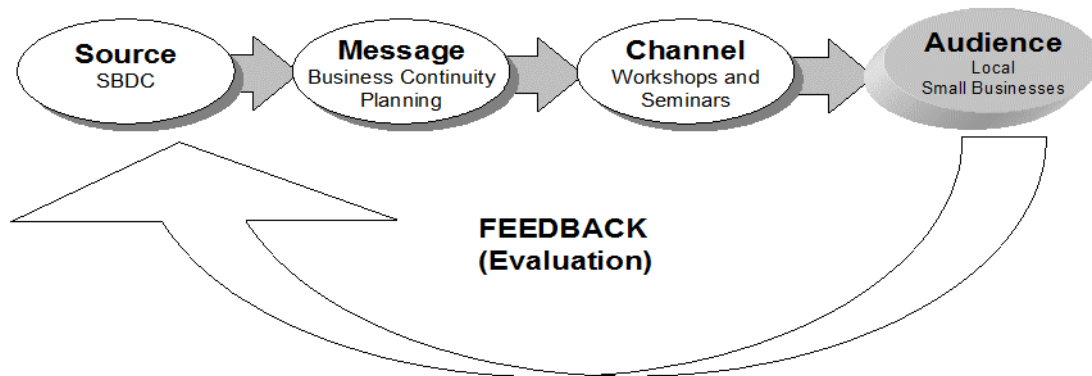
The following is a brief explanation of how the communication process works and how the community's existing social service providers could be used to provide natural hazard related messages to their clients.

There are five essential elements for communicating effectively to a target audience:

- The source of the message must be credible,
- The message must be appropriately designed,
- The channel for communicating the message must be carefully selected,
- The audience must be clearly defined, and
- The recommended action must be clearly stated and a feedback channel established for questions, comments and suggestions.

An example of an existing social system whose communication system can be linked to natural hazard mitigation is the Bend Chamber of Commerce. The Chamber (the source) provides local businesses (the audience) with information on business contingency planning (the message) through speakers at meetings (the channel). To target small businesses, Deschutes County can provide the Chamber with information on developing business continuity plans and strategies for recovering from a natural hazard. When local small businesses attend the Chamber's luncheons and seminars they can pick up this natural hazard mitigation information. This example is graphically presented in the following figure:

Figure C-5 Communication Process



Source: Adapted from the U.S. Environmental Protection Agency Radon Division's outreach program

Attachment C-A provides a list of existing social systems within Deschutes County. The document provides information on each organization or program's service area, types of services offered, populations served, and how the organization or program could be involved in natural hazard mitigation. The three involvement methods identified in the table are defined below:

- Education and outreach – organization could partner with the community to educate the public or provide outreach assistance on natural hazard preparedness and mitigation.
- Information dissemination – organization could partner with the community to provide hazard related information to target audiences.
- Plan/project implementation – organization may have plans and/or policies that may be used to implement mitigation activities or the organization could serve as the coordinating or partner organization to implement mitigation actions.

The information provided in attachment C-A can also be used to complete action item worksheets by identifying potential coordinating agencies and internal and external partners.

Civic Engagement

Civic engagement and involvement in local, state and national politics are important indicators of community connectivity. Those who are more invested in their community may have a higher tendency to vote in political elections. The 2020 Presidential General Election resulted in 84.0% voter turnout in the County as of November 20th, 2020.⁵⁰ These results are relatively higher compared to voter participation reported across the State (78.5%).⁵¹ Other indicators such as volunteerism, participation in formal community networks and community charitable

⁵⁰ Deschutes County Current & Upcoming Elections, <https://www.deschutes.org/clerk/page/current-upcoming-elections>, accessed March 2021.

⁵¹ Oregon Secretary of State Voter Statistics, General Elections Historical Turnout. <https://sos.oregon.gov/elections/pages/electionsstatistics.aspx>. Accessed March 2021

contributions are examples of other civic engagement that may increase community connectivity.

Cultural Resources

Historic Places

Historic and cultural resources such as historic structures and landmarks can help to define a community and may also be sources for tourism revenue. Protecting these resources from the impact of disasters is important because they have an important role in defining and supporting the community. According to the National Register Bulletin, “a contributing resource is a building, site, structure, or object adds to the historic associations, historic architectural qualities, or archeological values for which a property is significant because it was present during the period of significance, related to the documented significance of the property, and possesses historical integrity or is capable of yielding important information about the period; or it independently meets the National Register criteria.”⁵² If a structure does not meet these criteria, it is considered to be non-contributing.

The table below identifies the number of eligible/significant (ES) and eligible/contributing (EC) historical sites in Deschutes County. The table also shows how many ES and EC sites are listed on the National Register. Overall, there are a total of 838 historically registered places in Deschutes County.

Table C-26 Deschutes County Historic Places

Eligible Sites	Total Sites	Listed on the
ES-Significant	153	44
EC-Contributing	685	245

Source: Oregon Historic Sites Database, http://heritagedata.prd.state.or.us/historic/index.cfm?do=v.dsp_main

Libraries and Museums

Libraries and museums develop cultural capacity and community connectivity as they are places of knowledge and recognition, they are common spaces for the community to gather, and can serve critical functions in maintaining the sense of community during a disaster. They are recognized as safe places and reflect normalcy in times of distress. There are currently five community libraries in Deschutes County located in Bend, La Pine, Redmond, Sisters, and Sunriver. There are approximately three museums in Deschutes County, which have an emphasis on the history and culture of the region.

Cultural Events

Other such institutions that can strengthen community connectivity are the presence of festivals and organizations that engage diverse cultural interests. Examples of events and institutions include the Art in the High Desert on the banks of the Deschutes River and the Bend Film Festival. Not only do these events bring revenue into the community, they have potential to

⁵² U.S. Department of the Interior, National Park Service, Cultural Resources, National Register Bulletin 16A: "How to Complete the National Register Registration Form".

improve cultural competence and enhance the sense of place. Cultural connectivity is important to community resilience, as people may be more inclined to remain in the community because they feel part of the community and culture.

Community Stability

Residential Geographic Stability

Community stability is a measure of rootedness in place. It is hypothesized that resilience to a disaster stems in part from familiarity with place, not only for navigating the community during a crisis, but also accessing services and other supports for economic or social challenges.⁵³ The table below estimates residential stability across the region. It is calculated by the number of people who have lived in the same house and those who have moved within the same county a year ago, compared to the percentage of people who have migrated into the region. Deschutes County overall has a geographic stability rating of about 94% (i.e., 94% of the population lived in the same house or moved within the county). The figures of community stability are relatively consistent across the region; La Pine (82.8%) and Sisters (92.8%) show the least geographically stable population while Bend (94%) have the most geographically stable populations. Bend and Redmond have the greatest percent of their populations that lived in the same house one year ago; while La Pine and Sisters have less population that was in the same house one year ago than other cities.

Table C-27 Regional Residential Stability

Jurisdiction	Population	Geographic Stability	Same House	Moved Within Same County
Oregon	4,088,374	92.40%	82.90%	9.50%
Deschutes	184,909	92.00%	82.10%	9.90%
Bend	93,050	90.50%	80.20%	10.30%
La Pine	2,339	92.70%	87.00%	5.70%
Redmond	30,056	93.20%	77.50%	15.70%
Sisters	2,643	92.90%	85.50%	7.40%

Source: U.S. Census Bureau, 2019 American Community Survey, Table B07003.

Homeownership

Housing tenure describes whether residents rent or own the housing units they occupy. Homeowners are typically more financially stable but are at risk of greater property loss in a post-disaster situation. People may rent because they choose not to own, they do not have the financial resources for home ownership, or they are transient.

Collectively, over two-thirds of the occupied housing units in Deschutes County are owner-occupied. The county has a 4% higher owner occupied rate than the state. Conversely, one-third are renter occupied. The cities of Bend and Redmond have the highest percentage of owner-occupied households in the county. The city of Sisters has the highest renter-occupied

⁵³ Cutter, Susan, Christopher Burton, Christopher Emrich. "Disaster Resilience Indicators for Benchmarking Baseline Conditions". Journal of Homeland Security and Emergency Management.

rate. The county has a lower vacancy rate than the state; Sisters has the highest vacancy rate. In addition, seasonal or recreational housing accounts for approximately 12.5% of the county’s housing stock; Black Butte Ranch, Sisters, and Sunriver have the highest percentages.

Table C-28 Housing Tenure and Vacancy

	Total Occupied Units	Owner-occupied		Renter-occupied		Vacant [^]	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1611982	1005896	62.40%	606086	37.60%	94510	5.90%
Deschutes	74397	49809	67.00%	24588	33.00%	3198	4.30%
Bend	38312	22971	60.00%	15341	40.00%	1519	4.00%
La Pine	944	425	45.00%	519	55.00%	40	4.20%
Redmond	11369	6818	60.00%	4551	40.00%	235	2.10%
Sisters	1038	564	54.30%	474	45.70%	73	7.00%

Source: U.S. Census Bureau, 2019 American Community Survey, Tables DP04 & B25004.

[^] = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

According to Cutter, wealth increases resiliency and recovery from disasters. Renters often do not have personal financial resources or insurance to assist them post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk of natural hazards.⁵⁴ In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable post-disaster.

Synthesis

Deschutes County has distinct social and cultural resources that work in favor to increase community connectivity and resilience. Sustaining social and cultural resources, such as social services and cultural events, may be essential to preserving community cohesion and a sense of place. The presence of larger communities makes additional resources and services available for the public. However, it is important to consider that these amenities may not be equally distributed to the rural portions of the county and may produce implications for recovery in the event of a disaster.

In the long-term, it may be of specific interest to the county to evaluate community stability. A community experiencing instability and low homeownership may hinder the effectiveness of social and cultural resources, distressing community coping and response mechanisms.

Political Capacity

Political capacity is recognized as the government and planning structures established within the community. In terms of hazard resilience, it is essential for political capital to encompass diverse government and non-government entities in collaboration; as disaster losses stem from a predictable result of interactions between the physical environment, social and demographic characteristics and the built environment.⁵⁵ Resilient political capital seeks to involve various

⁵⁴ Cutter, S. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*.

⁵⁵ Mileti, D. 1999. Disaster by Design: a Reassessment of Natural Hazards in the United States. Washington D.C.: Joseph Henry Press.

stakeholders in hazard planning and works towards integrating the Natural Hazards Mitigation Plan with other community plans, so that all planning approaches are consistent.

Government Structure

All mitigation is local, and the primary responsibility for development and implementation of risk reduction strategies and policies lies with local jurisdictions. There are numerous partners and resources at the state and federal levels that have a role in natural hazards and natural hazard mitigation.

State and Federal

Key state agencies that are important in assisting Deschutes County include:⁵⁶

Oregon Military Department's Office of Emergency Management (OEM) is responsible for disaster mitigation, preparedness, response, and recovery at the state level and the administration of federal funds after a major disaster declaration.

Building Code Division (BCD) and local Community Development Departments are responsible for building code construction and for some hazards that are building-specific in their occurrence (such as earthquakes); also included are provisions for expansive soils, and damage assessment of buildings following an earthquake.

Oregon Department of Forestry (ODF) is responsible for all aspects of wildland fire protection on designated private and state forest lands. Private unprotected lands exist in central Oregon and are not designated for protection by ODF. ODF administers forest practice regulations, including landslide mitigation on non-federal lands;

USDA Forest Service and USDI Bureau of Land Management provides wildland fire protection on the federal lands within Deschutes. Together, they are identified as the Central Oregon Fire Management Service (COFMS). COFMS includes the Deschutes National Forest, the Ochoco National Forest, the Crooked River National Grassland, and the Prineville District of the BLM. These four units are managed cooperatively under combined leadership.

Oregon Department of Geology and Mineral Industries (DOGAMI) is responsible for geological hazard characterization, public education, the development of partnerships aimed at reducing risk, and exceptions (based on science-based refinement of tsunami inundation zone delineation) to state mandated tsunami zone restrictions.

Department of Land Conservation and Development (DLCD) is responsible for planning-based hazard management including implementation of land use planning and Statewide Planning Goal 7 (natural hazards), with attention given to hazard assessments and hazard mitigation.

Oregon Water Resources Department, South Central Region: The State of Oregon Water Resources Department deals with water supply needs and restores and protects streamflows and watersheds through enforcing Oregon's water laws.

⁵⁶ 2015 Deschutes County Natural Hazards Mitigation Plan

County

The **Board of County Commissioners**, comprised of three elected officials, elected at large, serves as the public's elected advocates and is the policy making body of Deschutes County government. The Board's duties include executive, judicial (quasi-judicial) and legislative authority over policy matters of countywide concern. The executive duties include establishment of the budget, which is done with the aid of the three lay members of the Budget Committee. To implement policy and manage the day-to-day operations of the County, the Board appoints a county administrator.

The Board's charge also includes creation and enforcement of County ordinances and, in general, the resolution of any problems arising between the citizenry and various County departments. In addition, the Board is involved in a host of regional and community efforts.

The County Counsel provides legal advice to county employees, elected officials, and county boards.

Almost all governing departments within Deschutes County have some degree of responsibility in contributing to community resilience. Every department plays a role in ensuring that county functions and normal operations resume after an incident, and the needs of the population are met.

Some divisions and departments of Deschutes County government that have a role in hazard mitigation are:⁵⁷

Economic Development: Supports business and industrial development, performs demographic and grant research, and is responsible for economic and community development in the county.

Environmental Health: Issues permits for septic systems and manages solid waste licensing and consultation programs.

Health Department: Offers preventive and community health services for county residents, such as immunizations, family planning, HIV testing and counseling, emergency preparedness, WIC, breast and cervical cancer programming, and maternal child health nurse home visiting programs.

Geographic Information System (GIS) division: Supports County Government by creating, managing, and analyzing spatial county data.

Community Development Department: Evaluates land use applications and submits staff reports to the Planning Commission and Board of County Commissioners, and responsible for zoning permits and facilitating the comprehensive planning process and long-range policy development.

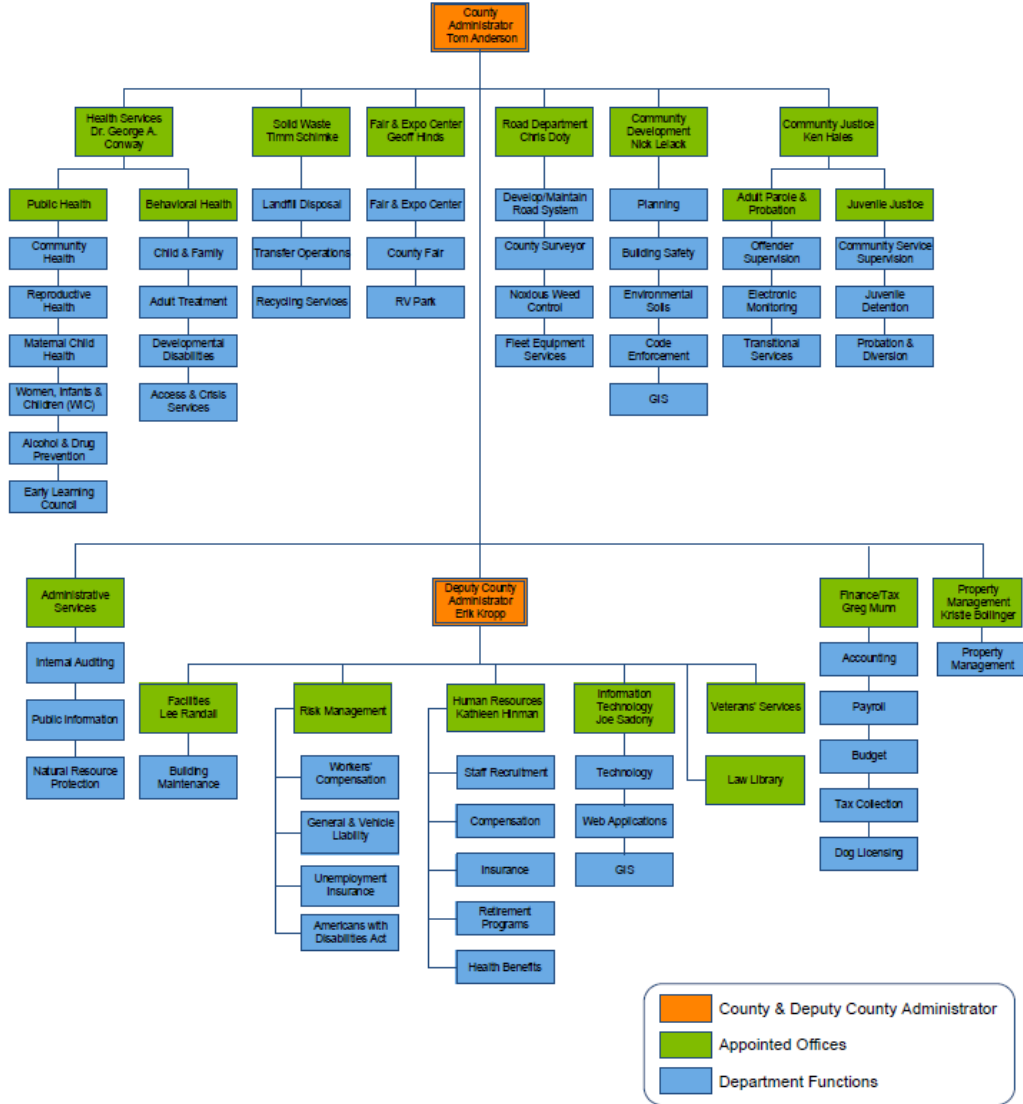
Road Department: Responsible for county road and bridge maintenance and construction, as well as shop and weed control.

Sheriff's Office: Responsible for Sheriff's administration, civil, concealed handgun licenses, corrections and jail, dispatch, emergency services, patrol, and investigation.

⁵⁷ Ibid.

Surveyor: Maintains a record of all surveys performed in the county by the county surveyor or licensed land surveyor and makes them available to the public. Protects, maintains, and reestablishes public land survey corners.

Figure C-6 Deschutes County Organizational Chart



Source: Deschutes County Fiscal Year 2021 Adopted Program Budget

The county’s incorporated communities have the following government structures as illustrated in the table below, for more information see the city addenda.

Table C-29 Participating City Government Structure

	Bend	La Pine	Redmond	Sisters
Government Form	Manager/Council	Manager/Council	Manager/Council	Manager/Council
City Manager/ Administrator	Yes	Yes	Yes	Yes
Mayor	Yes	Yes	Yes	Yes
City Council	7-Person	5-Person	7-Person	4-Person
Building	Yes	-	Yes	Yes
Parks/ Recreation	No	Yes	Yes	Yes
Planning	Yes	Yes	Yes	Yes
Public Works	Yes	Yes	Yes	Yes
Police	Yes	Yes**	Yes	Yes**
Fire	Yes	Yes	Yes	Yes
Information Technology	Yes	No	Yes	Yes

Source: City and County Websites

*Deschutes County Building Division provides services to Redmond through a contract

** Deschutes County Sheriff Substations in La Pine and Sisters

Existing Plans and Policies

Communities often have existing plans and policies that guide and influence land use, land development, and population growth. Such existing plans and policies can include comprehensive plans, zoning ordinances, and technical reports or studies. Plans and policies already in existence have support from 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.⁵⁸

The Deschutes County Natural Hazards Mitigation Plan includes a range of recommended action items that, when implemented, will reduce the county’s vulnerability to natural hazards. Many of these recommendations are consistent with the goals and objectives of the county’s existing plans and policies. Linking existing plans and policies to the Natural Hazards Mitigation Plan helps identify what resources already exist that can be used to implement the action items identified in the Plan. Implementing the natural hazards mitigation plan’s action items through existing plans and policies increases their likelihood of being supported and getting updated, and maximizes the county’s resources. In addition to the plans listed below the county and incorporated cities also have zoning ordinances (including floodplain development regulations) and building regulations.

The table below is a list of plans and policies already in place in Deschutes County that have a connection to natural hazards mitigation, for more information on city plans/ policies review the city addenda:

⁵⁸ Burby, Raymond J., ed. 1998. Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities.

Table C-30 Existing Plans

Jurisdiction	Document	Year
Deschutes County	Natural Hazards Mitigation Plan	2015
Deschutes County	2030 Comprehensive Plan	2011
Deschutes County	Newberry Country Plan	2013
Deschutes County	Development Code (Flood Ch 18.96, 18.108.19.72)	2007
Deschutes County	Emergency Operations Plan	2016
Deschutes County	Intelligent Transportation Systems Plan	2011
Deschutes County	Sunriver CWPP	2020
Deschutes County	Upper Deschutes CWPP	2018
Deschutes County	East & West Deschutes County	2018
City of Bend	Greater Bend CWPP	2016
City of Bend	Comprehensive Plan	2020
City of Bend	Development Code (Flood Section 10.10.22A.4)	2014
City of Bend	Emergency Operation Plan	2016
City of Bend	Transportation System Plan	2020
City of Bend	Water Public Facility Plan	coming in 2021)
City of Bend	Sewer Public Facility Plan	2018
City of Bend	Stormwater Public Facility Plan	2014
City of La Pine	Greater La Pine CWPP	2020
City of La Pine	Comprehensive Plan	2018
City of La Pine	Development Code (Flood Section 9.12)	2012
City of La Pine	Transportation System Plan	2013
City Of Redmond	Greater Redmond CWPP	2018
City Of Redmond	Comprehensive Plan	2015
City Of Redmond	Development Code (No Mapped Flood Plain)	
City Of Redmond	Transportation Master Plan	2008
City Of Redmond	Wastewater and Water System Master Plan	2007
City of Sisters	Greater Sisters CWPP	2019
City of Sisters	Comprehensive Plan	2005
City of Sisters	Transportation System Plan	2010
City of Sisters	Development Code (Flood, Section 2.10)	2012
City of Sisters	Greater Sisters Area Emergency Operations Plan	2009
City of Sisters	Water Capital Facilities Plan	2017
City of Sisters	Water Management and Conservation Plan	2011
City of Sisters	Wastewater System Capital Facilities Plan	2016

Source: City and County Websites, * - portions of these CWPPs include lands within County jurisdiction.

Existing Mitigation Activities

Current mitigation programs and activities are being implemented in an effort to reduce the community’s overall risk to natural hazards. Documenting these efforts can assist the community in better understanding its risk and can assist in documenting successes. The list below consists of countywide efforts; city-specific mitigation activities are listed in the city addendums.

Note: OEM has not documented any state- or federally-funded mitigation projects in Deschutes County (neither pre-disaster nor recovery mitigation).

Deschutes County Community Development Department

The community development department is responsible for providing comments and expertise on land use applications. The department reviews natural hazard impacts to development through enforcement of the county comprehensive plan and development code.

County Forester/ Project Wildfire

The County Forester helps private landowners create defensible space around their homes and helps coordinate fire adapted communities throughout Deschutes County. The County Forester works with federal, state, county, and municipality law enforcement agencies to resolve issues during wildland fires through programs, such as FireFree and Project Impact.

The FireFree program is a nationally recognized model for homeowner education and mitigation programs in the wildland urban interface. Created in 1997 following the devastating Skeleton Fire in Bend, FireFree creates awareness and educates residents about the risks of wildland fire to homes and property and the ten simple steps they can take to reduce those risks. FireFree encourages homeowners to take responsibility for risk mitigation by creating defensible space around their property and disposing of debris. Project Wildfire, is a collaborative effort among local fire agencies, forestry departments, private businesses, and the insurance industry coordinates FireFree.⁵⁹

Project Wildfire was established in 2002. Project Wildfire continues to provide coordination of a variety of wildland fire mitigation activities including the FireFree program, the facilitation of Community Wildfire Protection Plans, and serves as a source of information for local groups interested in obtaining grant funding to support mitigation activities.

Project Wildfire has established a web site (www.projectwildfire.org) to help showcase the wide variety of hazardous fuels treatment, prevention projects and public information and educational opportunities.⁶⁰

Deschutes County Emergency Services

The overall emergency management responsibility rests with the Deschutes County Sheriff. An appointed Emergency Manager is delegated to oversee the Emergency Management Program. The position is responsible for coordinating the plans of the different components of the emergency management system and assisting in coordination and support of: fire, police, emergency medical services, public works, volunteers, and other groups involved with the community's management of emergencies.

⁵⁹ Firefree. <http://www.firefree.org/>

⁶⁰ Project Wildfire. <https://www.projectwildfire.org/>

Bureau of Land Management (BLM Prineville District)

Deschutes County is located in the Bureau of Land Management's Prineville District. Prineville is the largest district in Oregon with 1.65 million acres scattered over 13 million acres. The districts mitigation projects have the potential to positively impact both the natural and human environment in the county and include the following:⁶¹

- Fuels Reduction – Treatments have occurred in the La Pine and Cline Buttes area for hazardous fuels.
- John Day Basin Resource Management Plan – will provide guidance for any decisions made about 450,000 acres of public land in the John Day Basin for the next 20 years
- River Management Plans – contains management actions necessary to protect and enhance resource values and resolve key issues that exist within river corridors

As addressed above, many governmental entities are responsible for work relevant to hazards planning; however, from this perspective it is challenging to decipher whether these structures work collaboratively in practice towards improving hazard mitigation. On a similar note, in short of reviewing each of the relevant policy documents it is questionable whether the documents effectively integrate hazard initiatives into implementation policy. Further analysis is needed to evaluate the effectiveness of political capital in terms of community resilience.

⁶¹ <http://www.blm.gov/or/districts/prineville/index.php>

ATTACHMENT A: DESCHUTES COUNTY SOCIAL SERVICE PROVIDERS

Name & Contact Information	Description	Service Area	Populations Served						Involvement with Natural Hazard Mitigation	
			Businesses	Children	Disabled	Elders	English Second Language	Families		Low Income
Boys & Girls Club- Redmond 1379 SW 15th Street Redmond, OR 97756 Phone: 541-504-9060	To inspire and enable all young people, especially those from disadvantaged circumstances, to realize their full potential as productive, responsible, and caring citizens	Redmond		X					X	<ul style="list-style-type: none"> • Education and outreach • Information dissemination
Boys & Girls Club- East Bend 1701 Tempest Drive Bend, OR 97702 Phone: 541-385-3009	To inspire and enable all young people, especially those from disadvantaged circumstances, to realize their full potential as productive, responsible, and caring citizens	Bend		X					X	<ul style="list-style-type: none"> • Education and outreach • Information dissemination
Central Oregon Intergovernmental Council 2363 SW Glacier Place Redmond, OR 97756 Phone: 541-548-8163 Fax: 541-548-9548	To provide education, retraining and economic development services	Crook, Deschutes and Jefferson counties and the cities of Bend, Culver, Madras, Metolius, Prineville, Redmond and Sisters							X	<ul style="list-style-type: none"> • Information dissemination

Healthy Beginnings 1029 NW 14th Street Bend, OR 97701	Provides physical, developmental and behavioral screenings to children age five and younger.	Deschutes County		X					X	
Money Management International 1010 NW 14th Street, Suite 100 Bend, OR 97701	Offers financial counseling and workshops.	Deschutes County	X					X	X	
CaCoon 2577 NE Courtney Drive Bend, OR 97701 Phone: 541-322-7400 Fax: 541-322-7465	CaCoon (Care COordinatiON) program that serves families with children who have a chronic health condition or disability.	Deschutes County		X	X			X	X	<ul style="list-style-type: none"> • Education and outreach • Information dissemination
Veteran's Services 1130 NW Harriman Street Bend, OR 97701 Phone: 541-38-3214	The Veterans' Service Office assists veterans and their dependents with submitting claims to the Veterans' Administration for several benefit programs related to disability.	Jefferson County			X	X				<ul style="list-style-type: none"> • Information dissemination
Deschutes Onsite Clinic 1340 NW Wall Street Bend, OR 97701 Phone: 541-317-3190	Provides health care to Deschutes County employees and their family members.	Deschutes County		X	X	X		X		<ul style="list-style-type: none"> • Education and outreach • Information dissemination

<p>Economic Development for Central Oregon (EDCO) 109 NW Greenwood Ave Suite 102 Bend, OR 97701 Phone: 541-388-3236</p>	<p>EDCO is a private non-profit organization dedicated to building a vibrant and thriving regional economy by attracting new investment and jobs through marketing, recruitment and working with existing employers.</p>	<p>Jefferson County, Crook, Deschutes</p>	<p>X</p>						<p>X</p>	<p>Coordinating mitigation activities with economic development in Jefferson County.</p>
<p>Girl Scouts of Oregon and SW Washington 908 NE 4th Street, Suite 101 Bend, OR 97701 Phone: 541-389-8146</p>	<p>To provide numerous volunteer services to community members in addition to preparing girls and young women for active participation in community life.</p>	<p>Central Oregon</p>	<p>X</p>	<p>X</p>	<p>X</p>	<p>X</p>			<p>X</p>	<p>• Education and outreach • Information dissemination</p>
<p>OSU Extension Service Deschutes County 3893 SW Airport Way Redmond, OR 97756 Phone: 541-548-6088</p>	<p>Provide research-based objective information to help people solve problems, develop leadership, and manage resources wisely surrounding the topics of horticulture, forestry and natural resources, youth development, family and community development, and nutrition information.</p>	<p>Deschutes County</p>	<p>X</p>	<p>X</p>					<p>x</p>	<p>• Education and outreach • Information dissemination • Plan/project implementation</p>

Name & Contact Information	Description	Service Area	Populations Served						Involvement with Natural Hazard Mitigation	
			Businesses	Children	Disabled	Elders	English Second Language	Families		Low Income
High Desert Food and Farm Alliance P.O. Box 1782 Bend, OR 97701 Phone: 541-504-3307	The High Desert Food and Farm Alliance is a non-profit whose mission is to support a sustainable community based food system in Central Oregon so that community members can have access to fresh and healthy food.	Deschutes County						X	X	<ul style="list-style-type: none"> • Education and outreach • Information dissemination
The Rotary Club of Greater Bend P.O. Box 6561 Bend, OR 97708	Rotary is a worldwide organization of business and professional leaders that provides humanitarian service, encourages high ethical standards in all vocations, and helps build goodwill and peace in the world.	Deschutes County	X	X	X	X		X	X	<ul style="list-style-type: none"> • Education and outreach • Information dissemination
Deschutes County Search and Rescue Foundation P.O. Box 5722 Bend, OR 97708 Phone: 541-357-7273	"The mission of the Foundation is to increase resources, raise funds, and promote public awareness in support of search and rescue volunteer activities conducted by the Deschutes County Sheriff's Office."	Deschutes County		X	X	X		X	X	<ul style="list-style-type: none"> • Education and outreach • Information dissemination • Plan/project implementation
Redmond Area Park and Recreation District 2241 SW Canal Blvd Redmond, OR 97756 Phone: 541-526-1847	Provides park and recreation facilities for community members in the Redmond Area	Redmond Area		X				X		<ul style="list-style-type: none"> • Education and outreach • Information dissemination"

Sisters Park and Recreation District 11650 W. McKinney Butte Rd Sisters, OR 97759 Phone: 541-549-2091	Provides youth and adult programs in Sisters. The park district is a non-profit organization which provides sports and recreation opportunities to community members.	Sisters			X		X			X		<ul style="list-style-type: none"> • Education and outreach • Information dissemination"
La Pine Park and Recreation P.O Box 664 La Pine, OR 97739 Phone: 541-536-2223	Provides adult education opportunities, after school programs for children, and activities for seniors.	La Pine			X		X			X		<ul style="list-style-type: none"> • Education and outreach • Information dissemination"
Bend Park and Recreation District 799 SW Columbia Street Bend, OR 97702 Phone: 541-399-7275	Maintains parkland around the community and offers recreational activities for children, families, and seniors.	Bend			X		X			X		<ul style="list-style-type: none"> • Education and outreach • Information dissemination"
Bend Senior Center 1600 SE Reed Market Rd Bend, OR 97702 Phone: 541-288-1133	Provides recreational activities and social activities and events for seniors in Bend.	Bend					X	X				<ul style="list-style-type: none"> • Education and outreach • Information dissemination
The Bend Kiwanis Club P.O. Box 102 Bend, OR 97709 Phone: 541-617-0003	The Bend Kiwanis Club supports the purchase park land in the community, Boy and Girl Scout clubs, scholarships, and other local nonprofits.	Bend			X					X		<ul style="list-style-type: none"> • Education and outreach • Information dissemination
Bend Elks Lodge #1371 63120 Boyd Acres Rd Bend, OR 97701 Phone: 541-389-7439	The group, made up of people who work to create a stronger community by supporting local and national charities that benefit children, the disabled, the elderly and low-income populations.	Deschutes County			X	X	X			X	X	<ul style="list-style-type: none"> • Education and outreach • Information dissemination

Name & Contact Information	Description	Service Area	Populations Served							Involvement with Natural Hazard Mitigation
			Businesses	Children	Disabled	Elders	English Second Language	Families	Low Income	
Sisters Area Chamber of Commerce 291 E Main St Sisters, OR 97759 Phone: 541-549-0251	Provide economic development assistance to local businesses.	Sisters	X							<ul style="list-style-type: none"> • Education and outreach • Information dissemination • Plan/project implementation
Redmond Chamber of Commerce 446 SW 7th St. Redmond, OR 97756 Phone: 541-923-5191	Provide economic development assistance to local businesses.	Redmond	X							<ul style="list-style-type: none"> • Education and outreach • Information dissemination • Plan/project implementation
La Pine Chamber of Commerce P.O. Box 616 La Pine, OR 97739 Phone: 541-536-8410	Provide economic development assistance to local businesses.	La Pine	X							<ul style="list-style-type: none"> • Education and outreach • Information dissemination • Plan/project implementation
Bend Chamber of Commerce 777 NW Wall Street, Suite 200 Bend, OR 97701 Phone: 541-385-9929	Provide economic development assistance to local businesses.	Bend	X							<ul style="list-style-type: none"> • Education and outreach • Information dissemination • Plan/project implementation

Deschutes County Personnel Office 1300 NW Wall Street, 2nd Floor Bend, OR 97701 Phone: 541-716-4722 Fax: 541-330-4626	Employment service	Deschutes County								X	<ul style="list-style-type: none"> • Information dissemination
Mid Oregon Personnel Services, INC. 2248 NE Division St Bend, OR 97701 Phone: 541-382-0445 Fax: 541-389-6094	Employment Service	Deschutes County								X	<ul style="list-style-type: none"> • Information dissemination
Opportunity Foundation of Central Oregon P.O. Box 430 835 Hwy 126 Redmond, OR 97756 Phone: 541-548-2611 Fax: 541-548-9573	The Opportunity Foundation of Central Oregon (OFCO) is a benchmark organization that is a leader in providing services to people in Central Oregon with disabilities.	Jefferson, Crook and Deschutes Counties			X						<ul style="list-style-type: none"> • Education and outreach • Information dissemination
Oregon Council for Hispanic Advancement 2600 NW College Way Bend, OR 97701 Phone: 541-330-4363 Fax: 541-317-3070	OCHA is a champion for Hispanics in Oregon, ensuring equity in education and economic opportunity by empowering Latino youth. OCHA's educational and advocacy activities empower Hispanics to make positive changes in their lives to optimize their future success.	Deschutes County				X				X	<ul style="list-style-type: none"> • Education and outreach • Information dissemination
Salvation Army 515 NE Dekalb Avenue Bend, OR 97701 Phone 541-389-8888	The group provides emergency assistance to people in need.	Bend								X	<ul style="list-style-type: none"> • Education and outreach • Information dissemination

<p>NeighborImpact Redmond Administrative Office 2303 SW First Street Redmond, OR 97756 Phone: 541-548-2380</p>	<p>The Head Start Program helps make sure that children 3-4 years old from low-income families are ready for school.</p>	<p>Crook and Deschutes County</p>	<p>X</p>							<ul style="list-style-type: none"> • Education and outreach • Information dissemination
<p>Housing Works 405 SW 6th Street Redmond, Oregon 97756 Phone: (541) 923-1018</p>	<p>Housing Works is the local housing authority for Deschutes, Crook and Jefferson counties. We provide affordable housing, rental assistance and new beginnings for low-and moderate-income Central Oregonians.</p>	<p>Deschutes, Crook, and Jefferson Counties</p>							<p>X</p>	<ul style="list-style-type: none"> • Education and outreach • Information dissemination

Appendix D: Economic Analysis of Natural Hazard Mitigation Projects

This appendix was developed by the Oregon Partnership for Disaster Resilience at the University of Oregon’s Institute for Policy Research and Engagement (IPRE). It has been reviewed and accepted by the Federal Emergency Management Agency as a means of documenting how the prioritization of actions shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

The appendix outlines three approaches for conducting economic analyses of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon Military Department – Office of Emergency Management, 2000), and Federal Emergency Management Agency Publication 331, *Report on Costs and Benefits of Natural Hazard Mitigation*. This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how an economic analysis can be used to evaluate mitigation projects.

Why Evaluate Mitigation Strategies?

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred. Evaluating possible natural hazard mitigation activities provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, law enforcement, utilities, and schools. Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce “ripple-effects” throughout the community, greatly increasing the disaster’s social and economic consequences.

While not easily accomplished, there is value from a public policy perspective, in assessing the positive and negative impacts from mitigation activities and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

Mitigation Strategy Economic Analyses Approaches

The approaches used to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into three general categories: benefit/cost analysis, cost-effectiveness analysis and the STAPLE/E approach. The distinction between the three methods is outlined below:

Benefit/Cost Analysis

Benefit/cost analysis is a key mechanism used by the state Oregon Office of Emergency Management (OEM), the Federal Emergency Management Agency (FEMA), and other state and federal agencies in evaluating hazard mitigation projects and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

Benefit/cost analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, to avoid disaster-related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoiding future damages, and risk. In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented. A project must have a benefit/cost ratio greater than 1 (i.e., the net benefits will exceed the net costs) to be eligible for FEMA funding. Unless an alternate approach is approved by FEMA, jurisdictions must use the latest available approved FEMA benefit/cost analysis (BCA) toolkit. Alternate approaches should be used with consultation from the State Hazard Mitigation Officer. See <https://www.fema.gov/benefit-cost-analysis> for more information.

Cost-Effectiveness Analysis

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

Investing in Public Sector Mitigation Activities

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions which involve a diverse set of beneficiaries and non-market benefits.

Investing in Private Sector Mitigation Activities

Private sector mitigation projects may occur based on one or two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or

landowner, whether a private entity or a public agency, required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or
4. Evaluate the most feasible alternatives and initiate the most cost-effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchases. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

STAPLE/E Approach

Considering detailed benefit/cost or cost-effectiveness analysis for every possible mitigation activity could be very time consuming and may not be practical. There are some alternate approaches for conducting a quick evaluation of the proposed mitigation activities which could be used to identify those mitigation activities that merit more detailed assessment. One of those methods is the STAPLE/E approach.

Using STAPLE/E criteria, mitigation activities can be evaluated quickly by steering committees in a synthetic fashion. This set of criteria requires the Steering Committee to assess the mitigation activities based on the Social, Technical, Administrative, Political, Legal, Economic and Environmental (STAPLE/E) constraints and opportunities of implementing the particular mitigation item in your community. The second chapter in FEMA's How-To Guide "Developing the Mitigation Plan – Identifying Mitigation Actions and Implementation Strategies" as well as the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process" outline some specific considerations in analyzing each aspect. The following are suggestions for how to examine each aspect of the STAPLE/E approach from the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process."

Social: Community development staff, local non-profit organizations, or a local planning board can help answer these questions.

- Is the proposed action socially acceptable to the community?
- Are there equity issues involved that would mean that one segment of the community is treated unfairly?
- Will the action cause social disruption?

Technical: The city or county public works staff and building department staff can help answer these questions.

- Will the proposed action work?

- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?
- Is it the most useful action considering other community goals?

Administrative: Elected officials or the city or county administrator, can help answer these questions.

- Can the community implement the action?
- Is there someone to coordinate and lead the effort?
- Is there sufficient funding, staff, and technical support available?
- Are there ongoing administrative requirements that need to be met?

Political: Consult the mayor, city council or city board of commissioners, city or county administrator, and local planning commissions to help answer these questions.

- Is the action politically acceptable?
- Is there public support both to implement and to maintain the project?

Legal: Include legal counsel, land use planners, risk managers, and city council or county planning commission members, among others, in this discussion.

- Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity?
- Are there legal side effects? Could the activity be construed as a taking?
- Is the proposed action allowed by the comprehensive plan, or must the comprehensive plan be amended to allow the proposed action?
- Will the community be liable for action or lack of action?
- Will the activity be challenged?

Economic: Community economic development staff, civil engineers, building department staff, and the assessor's office can help answer these questions.

- What are the costs and benefits of this action?
- Do the benefits exceed the costs?
- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private?)
- How will this action affect the fiscal capability of the community?
- What burden will this action place on the tax base or local economy?
- What are the budget and revenue effects of this activity?

- Does the action contribute to other community goals, such as capital improvements or economic development?
- What benefits will the action provide? (This can include dollar amount of damages prevented, number of homes protected, credit under the CRS, potential for funding under the HMGP or the FMA program, etc.)

Environmental: Watershed councils, environmental groups, land use planners and natural resource managers can help answer these questions.

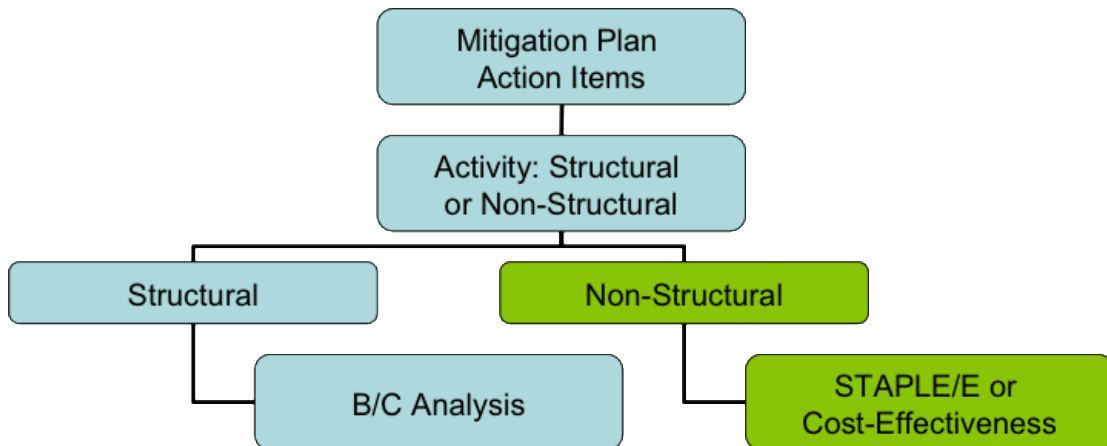
- How will the action impact the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

The STAPLE/E approach is helpful for doing a quick analysis of mitigation projects. Most projects that seek federal funding and others often require more detailed benefit/cost analyses.

When to use the Various Approaches

It is important to realize that various funding sources require different types of economic analyses. The following figure is to serve as a guideline for when to use the various approaches.

Figure D-I Economic Analysis Flowchart



Source: Oregon Partnership for Disaster Resilience. 2005.

Implementing the Approaches

Benefit/cost analysis, cost-effectiveness analysis, and the STAPLE/E are important tools in evaluating whether to implement a mitigation activity. A framework for evaluating

mitigation activities is outlined below. This framework should be used in further analyzing the feasibility of prioritized mitigation activities.

1. Identify the Activities

Activities for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation projects can assist in minimizing risk to natural hazards but do so at varying economic costs.

2. Calculate the Costs and Benefits

Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate activities. Potential economic criteria to evaluate alternatives include:

- **Determine the project cost.** This may include initial project development costs, and repair and operating costs of maintaining projects over time.
- **Estimate the benefits.** Projecting the benefits, or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.
- **Consider costs and benefits to society and the environment.** These are not easily measured but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.
- **Determine the correct discount rate.** Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Activities

Once costs and benefits have been quantified, economic analysis tools can rank the possible mitigation activities. Two methods for determining the best activities given varying costs and benefits include net present value and internal rate of return.

- **Net present value.** Net present value is the value of the expected future returns of an investment minus the value of the expected future cost expressed in today's dollars. If the net present value is greater than the projected costs, the project may be determined feasible for implementation. Selecting the discount rate and

identifying the present and future costs and benefits of the project calculates the net present value of projects.

- **Internal rate of return.** Using the internal rate of return method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project. Once the mitigation projects are ranked based on economic criteria, decision-makers can consider other factors, such as risk, project effectiveness, and economic, environmental, and social returns in choosing the appropriate project for implementation.

Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or land owners because of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over time.

Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change because of a large natural disaster. These are usually termed “indirect” effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports

- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, small business development, critical infrastructure, and transportation projects among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

Resources

CUREe Kajima Project, *Methodologies for Evaluating the Socio-Economic Consequences of Large Earthquakes*, Task 7.2 Economic Impact Analysis, Prepared by University of California, Berkeley Team, Robert A. Olson, VSP Associates, Team Leader; John M. Eiding, G&E Engineering Systems; Kenneth A. Goettel, Goettel and Associates, Inc.; and Gerald L. Horner, Hazard Mitigation Economics Inc., 1997

Federal Emergency Management Agency, *Benefit/Cost Analysis of Hazard Mitigation Projects*, Riverine Flood, Version 1.05, Hazard Mitigation Economics, Inc., 1996

Federal Emergency Management Agency, [Report on the Costs and Benefits of Natural Hazard Mitigation](#). Publication 331, 1996.

Goettel & Horner Inc., *Earthquake Risk Analysis Volume III: The Economic Feasibility of Seismic Rehabilitation of Buildings in the City of Portland*, Submitted to the Bureau of Buildings, City of Portland, August 30, 1995.

Goettel & Horner Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects Volume V, Earthquakes*, Prepared for FEMA's Hazard Mitigation Branch, October 25, 1995.

Horner, Gerald, *Benefit/Cost Methodologies for Use in Evaluating the Cost Effectiveness of Proposed Hazard Mitigation Measures*, Robert Olsen Associates, Prepared for Oregon Military Department – Office of Emergency Management, July 1999.

Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, 2000.)

Risk Management Solutions, Inc., *Development of a Standardized Earthquake Loss Estimation Methodology*, National Institute of Building Sciences, Volume I and II, 1994.

VSP Associates, Inc., *A Benefit/Cost Model for the Seismic Rehabilitation of Buildings*, Volumes 1 & 2, Federal Emergency management Agency, FEMA Publication Numbers 227 and 228, 1991.

VSP Associates, Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects: Section 404 Hazard Mitigation Program and Section 406 Public Assistance Program, Volume 3: Seismic Hazard Mitigation Projects*, 1993.

VSP Associates, Inc., *Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model*, Volume 1, Federal Emergency Management Agency, FEMA Publication Number 255, 1994.

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APPENDIX E: GRANT PROGRAMS AND RESOURCES

Introduction

There are numerous local, state and federal funding sources available to support natural hazard mitigation projects and planning. The following section includes an abbreviated list of the most common funding sources utilized by local jurisdictions in Oregon. Because grant programs often change, it is important to periodically review available funding sources for current guidelines and program descriptions.

Post-Disaster Federal Programs

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP involves a paper application which is first offered to the counties with declared disasters within the past year, then becomes available statewide if funding is still available.

<http://www.fema.gov/hazard-mitigation-grant-program>

Physical Disaster Loan Program

When physical disaster loans are made to homeowners and businesses following disaster declarations by the U.S. Small Business Administration (SBA), up to 20% of the loan amount can go towards specific measures taken to protect against recurring damage in similar future disasters. <http://www.sba.gov/category/navigation-structure/loans-grants/small-business-loans/disaster-loans>

Pre-Disaster Federal Programs

Building Resilient Infrastructure and Communities Grant Program

The Building Resilient Infrastructure and Communities (BRIC) program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. BRIC grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds. The BRIC grant program is offered annually; applications are submitted online. Applicants need a user profile approved by the State Hazard Mitigation Officer, which should be garnered well before the application period opens. <https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities>

Flood Mitigation Assistance Program

The overall goal of the Flood Mitigation Assistance (FMA) Program is to fund cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other National Flood Insurance Program (NFIP) insurable structures. This specifically includes:

- Reducing the number of repetitively or substantially damaged structures and the associated flood insurance claims;
- Encouraging long-term, comprehensive hazard mitigation planning;
- Responding to the needs of communities participating in the NFIP to expand their mitigation activities beyond floodplain development activities; and
- Complementing other federal and state mitigation programs with similar, long-term mitigation goals.

<http://www.fema.gov/flood-mitigation-assistance-program>

Detailed program and application information for federal post-disaster and pre-disaster programs can be found in the FY15 Hazard Mitigation Assistance Unified Guidance, available at: <https://www.fema.gov/media-library/assets/documents/103279>. Note that guidance regularly changes. Verify that you have the most recent edition. Flood mitigation assistance is usually offered annually; applications are submitted online. Applicants need a user profile approved by the State Hazard Mitigation Officer, which should be garnered well before the application period opens.

For Oregon Office of Emergency Management (OEM) grant guidance on Federal Hazard Mitigation Assistance, visit:

<https://www.oregon.gov/OEM/emresources/Grants/Pages/HMA.aspx>

Contact: Amie Bashant, amie.bashant@state.or.us or shmo@mil.state.or.us

State Programs

Special Public Works Fund

The Special Public Works Fund (SPWF) provides funds for publicly owned facilities that support economic and community development in Oregon. Funds are available to public entities for: planning, designing, purchasing, improving and constructing publicly owned facilities, replacing publicly owned essential community facilities, and emergency projects as a result of a disaster. Public agencies that are eligible to apply include: cities, counties, county service districts, (organized under ORS Chapter 451), tribal councils, ports, districts as defined in ORS 198.010, and airport districts (ORS 838). Facilities and infrastructure projects that are eligible for funding are: airport facilities, buildings and associated equipment, levee accreditation, certification, and repair, restoration of environmental conditions on publicly-owned industrial lands, port facilities, wharves, and docks, the purchase of land, rights of way and easements necessary for a public facility, telecommunications facilities, railroads, roadways and bridges, solid waste disposal sites, storm drainage systems, wastewater systems, and water systems. <https://www.orinfrastructure.org/Infrastructure-Programs/SPWF/>

Seismic Rehabilitation Grant Program

The Seismic Rehabilitation Grant Program (SRGP) provides state funds to strengthen public schools and emergency services buildings so they will be less damaged during an earthquake. Reducing property damage, injuries, and casualties caused by earthquakes is the goal of the SRGP. <http://www.orinfrastructure.org/Infrastructure-Programs/Seismic-Rehab/>

Community Development Block Grant Program

The Community Development Block Grant Program promotes viable communities by providing: 1) decent housing; 2) quality living environments; and 3) economic opportunities, especially for low- and moderate-income persons. Eligible activities most relevant to natural hazards mitigation include: acquisition of property for public purposes; construction/reconstruction of public infrastructure; community planning activities. Under special circumstances, CDBG funds also can be used to meet urgent community development needs arising in the last 18 months which pose immediate threats to health and welfare.

http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs

Oregon Watershed Enhancement Board

While OWEB's primary responsibilities are implementing projects addressing coastal salmon restoration and improving water quality statewide, these projects can sometimes also benefit efforts to reduce flood and landslide hazards. In addition, OWEB conducts watershed workshops for landowners, watershed councils, educators, and others, and conducts a biennial conference highlighting watershed efforts statewide. Funding for OWEB programs comes from the general fund, state lottery, timber tax revenues, license plate revenues, angling license fees, and other sources. OWEB awards approximately \$20 million in funding annually. More information at: <http://www.oregon.gov/OWEB/Pages/index.aspx>

Federal Mitigation Programs, Activities & Initiatives

Basic & Applied Research/Development

National Earthquake Hazard Reduction Program (NEHRP), National Science Foundation.

Through broad based participation, the NEHRP attempts to mitigate the effects of earthquakes. Member agencies in NEHRP are the US Geological Survey (USGS), the National Science Foundation (NSF), the Federal Emergency Management Agency (FEMA), and the National Institute for Standards and Technology (NIST). The agencies focus on research and development in areas such as the science of earthquakes, earthquake performance of buildings and other structures, societal impacts, and emergency response and recovery. <http://www.nehrp.gov/>

Decision, Risk, and Management Science Program, National Science Foundation.

Supports scientific research directed at increasing the understanding and effectiveness of decision making by individuals, groups, organizations, and society. Disciplinary and interdisciplinary research, doctoral dissertation research, and workshops are funded in the areas of judgment and decision making; decision analysis and decision aids; risk analysis,

perception, and communication; societal and public policy decision making; management science and organizational design. The program also supports small grants for exploratory research of a time-critical or high-risk, potentially transformative nature.

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5423

Hazard ID and Mapping

National Flood Insurance Program: Flood Mapping; FEMA

Flood insurance rate maps and flood plain management maps for all NFIP communities.

<http://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping>

National Map: Orthoimagery, DOI – USGS

Develops topographic quadrangles for use in mapping of flood and other hazards.

<https://nationalmap.gov/ortho.html>

Mapping Standards Support, DOI-USGS

Expertise in mapping and digital data standards to support the National Flood Insurance Program. <http://ncgmp.usgs.gov/standards.html>

Soil Survey, USDA-NRCS

Maintains soil surveys of counties or other areas to assist with farming, conservation, mitigation or related purposes. http://soils.usda.gov/survey/printed_surveys/

Resilience Analysis and Planning Tool, FEMA

A free GIS web map that allows federal, state, local, tribal and territorial emergency managers and other community leaders to examine the interplay of census data, infrastructure locations, and hazards, including real-time weather forecasts, historic disasters and estimated annualized frequency of hazard risk.

<https://www.fema.gov/emergency-managers/practitioners/resilience-analysis-and-planning-tool>

Oregon Wildfire Risk Explorer (OWRE)

The OWRE Advanced Report provides wildfire risk information for a customized area of interest to support Community Wildfire Protection Plans (CWPPs), Natural Hazard Mitigation Plans (NHMPs), and fuels reduction and restoration treatments in wildfire-prone areas in Oregon.

The Advanced OWRE map viewer provides wildfire risk assessment data primarily from the 2018 Pacific Northwest Quantitative Wildfire Risk Assessment, produced by the US Forest Service with a coalition of local fire managers, planners, and natural resource specialists in both Washington and Oregon. The assessment uses the most current data (incorporating 2017 fires) and state-of-the-art fire modeling techniques, and is the most up-to-date wildfire risk assessment for Oregon. The assessment characterizes risk of large wildfires (>250 acres). Data also comes from the 2013 West Wide Wildfire Risk Assessment, Oregon

Department of Forestry (ODF), and other sources.

https://tools.oregonexplorer.info/oe_htmlviewer/index.html?viewer=wildfireplanning

Project Support

Coastal Zone Management Program, NOAA

Provides grants for planning and implementation of non-structural coastal flood and hurricane hazard mitigation projects and coastal wetlands restoration.

<http://coastalmanagement.noaa.gov/>

Community Development Block Grant Entitlement Communities Program, US Department of Housing and Urban Development

Provides grants to entitled cities and urban counties to develop viable communities (e.g., decent housing, a suitable living environment, expanded economic opportunities), principally for low- and moderate- income persons.

http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/entitlement

National Fire Plan (DOI – USDA)

The NFP provides technical, financial, and resource guidance and support for wildland fire management across the United States. This plan addresses five key points: firefighting, rehabilitation, hazardous fuels reduction, community assistance, and accountability.

<http://www.forestsandrangelands.gov/>

Assistance to Firefighters Grant Program, FEMA

FEMA AFGM grants are awarded to fire departments to enhance their ability to protect the public and fire service personnel from fire and related hazards. Three types of grants are available: Assistance to Firefighters Grant (AFG), Fire Prevention and Safety (FP&S), and Staffing for Adequate Fire and Emergency Response (SAFER).

<http://www.fema.gov/welcome-assistance-firefighters-grant-program>

Emergency Watershed Protection Program, USDA-NRCS

Provides technical and financial assistance for relief from imminent hazards in small watersheds, and to reduce vulnerability of life and property in small watershed areas damaged by severe natural hazard events.

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp>

Rural Development Assistance – Utilities, USDA

Direct and guaranteed rural economic loans and business enterprise grants to address utility issues and development needs.

http://www.rurdev.usda.gov/Utilities_Programs_Grants.html

Rural Development Assistance – Housing, USDA

The RDA program provides grants, loans, and technical assistance in addressing rehabilitation, health and safety needs in primarily low-income rural areas. Declaration of major disaster necessary. <http://www.rurdev.usda.gov/HAD-HCFPGGrants.html>

Public Assistance Grant Program, FEMA

The objective of FEMA Public Assistance (PA) Grant Program is to aid State, Tribal and local governments, and certain types of Private Nonprofit organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President. <http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit>

National Flood Insurance Program, FEMA

The NFIP makes available flood insurance to residents of communities that adopt and enforce minimum floodplain management requirements. <http://www.fema.gov/national-flood-insurance-program>

HOME Investments Partnerships Program, HUD

The HOME IPP provides grants to states, local government and consortia for permanent and transitional housing (including support for property acquisition and rehabilitation) for low-income persons. <http://www.hud.gov/offices/cpd/affordablehousing/programs/home/>

Disaster Recovery Initiative, HUD

The DRI provides grants to fund gaps in available recovery assistance after disasters (including mitigation).
http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/dri

Emergency Management Performance Grants, FEMA

EMPG grants help state and local governments to sustain and enhance their all-hazards emergency management programs. <http://www.fema.gov/fy-2012-emergency-management-performance-grants-program>

Partners for Fish and Wildlife, DOI – FWS

The PFW program provides financial and technical assistance to private landowners interested in pursuing restoration projects affecting wetlands and riparian habitats. <http://www.fws.gov/partners/>

North American Wetland Conservation Fund, DOI-FWS

NAWC fund provides cost-share grants to stimulate public/private partnerships for the protection, restoration, and management of wetland habitats. <http://www.fws.gov/birdhabitat/Grants/index.shtm>

Federal Land Transfer / Federal Land to Parks Program, DOI-NPS

Identifies, assesses, and transfers available federal real property for acquisition for State and local parks and recreation, such as open space. <http://www.nps.gov/ncrc/programs/flp/index.htm>

Wetlands Reserve program, USDA-NCRS

The WR program provides financial and technical assistance to protect and restore wetlands through easements and restoration agreements.

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/wetlands>

Secure Rural Schools and Community Self-Determination Act of 2000, US Forest Service

Reauthorized for FY2012, it was originally enacted in 2000 to provide five years of transitional assistance to rural counties affected by the decline in revenue from timber harvests on federal lands. Funds have been used for improvements to public schools, roads, and stewardship projects. Money is also available for maintaining infrastructure, improving the health of watersheds and ecosystems, protecting communities, and strengthening local economies. <http://www.fs.usda.gov/pts/>

APPENDIX F: DESCHUTES COUNTY NATURAL HAZARDS COMMUNITY SURVEY

Survey Purpose and Use

The purpose of this survey was to gauge the overall perception of natural disasters, determine a baseline level of loss reduction activity for residents in the community, and assess citizen's support for different types of individual and community risk reduction activities.

Data from this survey directly informs the natural hazard planning process. Deschutes County can use this survey data to enhance action item rationale and ideas for implementation. Other community organizations can also use survey results to inform their own outreach efforts. Data from the survey provides the county with a better understanding of desired outreach strategies (sources and formats), a baseline understanding of what people have done to prepare for natural hazards, and desired individual and community strategies for risk reduction.

Background

In addition to establishing a comprehensive community-level mitigation strategy, the Disaster Mitigation Act of 2000 (DMA2K) and the regulations contained in 44 CFR 201 require that jurisdictions maintain an approved NHMP in order to receive federal funds for mitigation projects. Development of the Natural Hazards Mitigation Plan update process for Deschutes County was pursued in compliance with subsections from 44 CFR 201.6 guidelines.

Citizen involvement is a key component in the natural hazard mitigation planning process. Citizens should have the opportunity to voice their ideas, interests and concerns about the impact of natural disasters on their communities. To that end, the DMA2K requires citizen involvement in the natural hazard mitigation planning process. It states: "An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:



1. An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval
2. An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process."

According to Bierle¹, the benefits of citizen involvement include the following: (1) educate and inform public; (2) incorporate public values into decision making; (3) substantially improve the quality of decisions; (4) increase trust in institutions; (5) reduce conflict; and (6) ensure cost effectiveness.

Methodology

In March 2021, Central Oregon Intergovernmental Council (COIC) and Deschutes County administered a survey online via Survey Monkey. The survey was made available in both Spanish and English and was distributed via the County webpage, and COIC's project website. A press release was created, and at least one news article directed the public to the survey (See Appendix B: Public Process for a copy of the press release). Two flyers (Spanish and English), as shown in figures F-1 and F-2 below, were also distributed via the County and COIC's social media pages (Facebook, Twitter, Instagram).

Figure F-1: 2021 Community Preparedness Survey Flyer (English)

 **Deschutes County is updating the Natural Hazard Mitigation Plan!** 

And we need your input to help make your community safer. Please fill out the survey below by March 19.


This survey is organized in partnership with Central Oregon Intergovernmental Council (COIC). All results are confidential and help develop a robust Natural Hazard Mitigation Plan (NHMP) for Deschutes County and its cities.

<https://www.surveymonkey.com/r/DeschutesNHMP>

La encuesta para el Plan de mitigación para los desastres naturales está también disponible en español:
<https://www.surveymonkey.com/r/DeschutesNHMP-Espanol>

Espanol

Questions?
Contact
Shelby Knight at
sknight@coic.org or
541-548-9535

 To request this information in an alternate format, please call **541-728-3872** or send an email to emergency.management@deschutes.org

¹ Bierle, T. 1999. "Using social goals to evaluate public participation in environmental decisions." Policy Studies Review. 16(3/4), 75---103.

Figure F-2: 2021 Community Preparedness Survey Flyer (Spanish)



¡El condado Deschutes está actualizando el Plan de mitigación de desastres naturales!

Y necesitamos sus sugerencias para ayudar a que su comunidad sea más segura. Por favor, complete la encuesta a continuación antes del 19 de marzo.

Esta encuesta es organizada en asocio con el Central Oregon Intergovernmental Council, COIC (El Consejo intergubernamental del Centro de Oregon). Todas las respuestas son confidenciales y ayudan a desarrollar un robusto Natural Hazard Mitigation Plan, NHMP (Plan de mitigación de desastres naturales) para el condado Deschutes y sus ciudades.

<https://www.surveymonkey.com/r/DeschutesNHMP-Espanol>

The survey for the Natural Hazard Mitigation Plan is also available in English:
<https://www.surveymonkey.com/r/DeschutesNHMP>

¿Preguntas?
Contacte a
emergency.management@deschutes.org
o 541-728-3872



Para solicitar esta información en un formato alternativo, llame **541-728-3872** o envíe un correo electrónico a emergency.management@deschutes.org

A total of 30 surveys in English, one in Spanish were submitted, however, the Spanish survey did not include any responses and is therefore omitted from the results below. The survey consisted of 44 questions divided into four sections: natural hazard information, community natural hazard mitigation strategies and priorities, mitigation and preparedness activities in your household, and general household information. The questions were designed to determine public perceptions and opinions regarding natural hazards. Questions also focused on the methods and techniques survey respondents prefer to use in reducing the risks and losses associated with natural hazards. The intent of this survey was not to be statistically valid but instead to gain the perspective and opinions of resident's regarding natural hazards in the region. Our assessment is that the results reflect a range attitudes and opinions of residents throughout the county.

Survey Results

This section presents the response report generated by Survey Monkey (Attachment A). Key themes and considerations gleaned from the outcomes of the survey are also discussed below. Finally, Attachment B includes the initial surveys distributed in both Spanish and English.

Key Consideration and Outcomes

The Project Management Team reviewed the survey results in detail, and noted the following outcomes as key considerations:

- The top concerns for survey respondents in regards to hazards were Wildfire, Drought, and Winter Storm.
- Over 85% of respondents have received information about natural hazards. The main sources of information received were government agencies, news media, Red Cross, and utilities.
- Survey respondents identified the following as the most effective routes for emergency services professionals and agencies for sharing information: social media, online news outlets, fact sheets/brochures/university or research institutions.
- Respondent top priorities were as follows: protecting critical facilities, protecting and reducing damage to utilities, preventing development in hazard areas.
- Respondents felt Deschutes County is either somewhat prepared (38%) or weren't sure (31%) for natural hazards.
- 73% of respondents felt they have an awareness of mitigation activities in Deschutes County.
- A majority of respondents have participated in some form of personal preparedness activities, but were least likely to have a utility shut off plan.
- Feedback for next time included having more options for cultural and traditional resources in the area, and reducing the overall length of the survey.

In response to the survey outcomes and key considerations, the Project Management Team agreed to review the mitigation action plan to ensure there are action items that address the gaps and needs highlighted by responses. After a thorough review, the Team agreed community concerns and needs are addressed in the action plan.

ATTACHMENT A: SURVEY RESULTS

**ATTACHMENT B:
COMMUNITY PREPAREDNESS SURVEY (ENGLISH)**

**ATTACHMENT C:
COMMUNITY PREPAREDNESS SURVEY (SPANISH)**